

Technical Report No. 197

**FIELD STUDY OF
AIR POLLUTION
TRANSPORT
IN THE
SOUTH COAST
BASIN**

FINAL REPORT

PREPARED FOR

**State of California
AIR RESOURCES BOARD**
1709 11th Street
Sacramento, CA 95814

Contract No. ARB 658

June 1974



3201 PORTER DRIVE • PALO ALTO, CALIFORNIA 94304



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TRANSPORT IN THE SOUTH COAST
AIR BASIN

FINAL REPORT

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PREPARED FOR:
STATE OF CALIFORNIA
AIR RESOURCES BOARD
SACRAMENTO, CALIFORNIA

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ABSTRACT

A total of seven fluorescent particle (FP) atmospheric tracer studies were conducted in the South Coast Air Basin of California during the summer and fall of 1972 and 1973. Distinguishable tracers were simultaneously released from areas in Los Angeles, Torrance and Santa Ana to simulate automotive emissions. In addition, tests conducted in 1973 included a fourth tracer, released from a smoke stack in the Long Beach area, to simulate industrial emissions.

A network of up to sixty tracer sampling stations was used to determine the transport and diffusion of the labeled air masses. Comparisons of tracer material transport and pollutants such as carbon monoxide, sulfur dioxide and oxidant are discussed. Overall results are correlated with meteorological conditions extant during tests and with long term meteorological frequencies.

Results are presented primarily as a series of maps showing wind streamlines and effective tracer concentration as a function of time.

This report was submitted in fulfillment of Project Number ARB-658 by Metronics Associates, Inc. under the sponsorship of the California Air Resources Board. Work was completed as of 31 May 1974.

DEDICATION

The authors wish to dedicate this report to the memory of Francis X. Webster and Dale H. Hutchison.

Mr. Webster was one of the founders of Metronics Associates, Inc. and one of the originators of the fluorescent particle tracer technique. He was of great assistance in the planning and execution of this work before his death in August 1972.

Dr. Hutchison was Chief of Research at the California Air Resources Board. His assistance and valuable suggestions were of great help in the conduct of this program before his death in August 1973.

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The authors wish to acknowledge the assistance of a great many people in the design and execution of this study. We thank the personnel at the California Air Resources Board who helped in the planning and coordination of field operations. We gratefully acknowledge the assistance of many people at the Air Pollution Control Districts of the four counties making up the South Coast Air Basin, and appreciate the help received from the National Oceanic and Atmospheric Administration. In particular, we wish to thank Mr. Al Cuba, Mr. Melvin Zeldin, and Mr. Donald Lust for their personal assistance in this project.

Information received from personnel of Meteorology Research, North American Weather Consultants, DASIBI and the Statewide Air Pollution Research Center is greatly appreciated.

We are greatly indebted to our co-workers at Metronics Associates for their many contributions, and especially to Mr. George B. Webster, Mr. George M. Kohler, and Mr. Robert A. Nunes.

We thank the people who so generously cooperated with our field crews and, in particular, Mr. Wes Pepper of the Los Angeles Water and Power Harbor Steam Plant.

We especially wish to express our thanks to the many people at Fire Departments, the U. S. Forest Service, Military bases, schools, businesses and private homes in Southern California who volunteered to operate the extensive sampling network so necessary to the success of this project.

CONCLUSIONS

1. The South Coast Air Basin must be considered as a single entity with respect to transport and diffusion of polluted air masses. Polluted air moves over long distances within the Basin, adding to the local pollution of several communities.
2. Transport of pollution from both elevated and ground-level sources is affected by winds above the generally accepted "mixing layer." Interchange of air between layers produces complex and sometimes discontinuous patterns of pollution at ground level.
3. Elevated sources reduce ground-level concentrations of effluents in the Los Angeles Basin during the morning hours. However, during the afternoon, strong vertical mixing produces concentrations comparable to those from equivalent ground-level sources at distances greater than 25 km from the source.
4. Conditions associated with moderate basin-wide oxidant levels often decrease the stagnation of polluted air in the Basin. The average percentage of polluted air remaining from one day to the next in the 1973 test series was only 4% compared to 14% found in the 1972 test series.
5. Maximum hourly average oxidant levels within the South Coast Air Basin are closely related to the temperature at the top of the inversion layer. This parameter in conjunction with inversion strength and height of the inversion base provides a means of classifying test days and estimating their climatological frequencies.

RECOMMENDATIONS

1. Inclusion of upper level wind and temperature information should be required in calculations aimed at predicting the effects of either elevated or ground-level sources of pollution.
2. Quantitative measurements of the vertical interchange between surface and higher levels of the atmosphere should be made. This information would improve the accuracy and applicability of mathematical models used to predict the effects of various control strategies.
3. Further analysis of relationships between pollutant concentration and meteorological regimes should be undertaken. Such analysis would increase the usefulness of data currently being collected and could serve as the basis of a system for forecasting pollution episodes.

INTRODUCTION

The transport and diffusion of polluted air masses in the South Coast Air Basin of California was the subject of a series of field studies conducted in the summer and fall of 1972 and 1973. This final report includes a detailed look at the 1973 test series as well as a generalized review of the entire study.

TRACER METHOD

In order to quantitatively define the trajectories and dispersion of air masses in the Basin, an atmospheric tracer was used. In essence the technique consists of dispersing an easily identified substance into the air (Page 16). The labeled air masses can then be followed by analyzing for the tracer material. Since the initial quantity and time of release of the tracer are known, maps of tracer concentrations as a function of time can be generated which quantitatively define the transport route and the degree of dispersion of the original air mass.

The tracer material used in this study consisted of fluorescent particles (FP) with a number mean diameter of approximately two microns. No appreciable settling or degradation occurs with particles in this size range, yet they are large enough for easy visual analysis. The FP tracer materials were collected on Rotorod * impactors and numerically assessed by microscopic inspection under ultraviolet light. The tracer materials glow brightly with distinctive colors under illumination with 366 nm light which makes them easily distinguishable from naturally occurring substances (Page 17). Yellow, green, blue, and red glowing tracer materials were used.

The Rotorod sampler collects particles by impaction on a specially coated metal surface which is moved through the air by rotation at high speed. The sampled volume is approximately 40 liters per minute. Collection efficiency for particles in the size range of tracer material

averages approximately 35% (Table 1). The collection surfaces are shielded when not actually in operation by a channel in the support beam (Page 17). Thus, tracer material is collected only during the proper time period. After the entire test sequence is complete, the collector rods are shipped in special containers to the laboratory for analysis. The collection surfaces are removed from the support beam and sealed between glass plates (Page 17). This process provides an easily handled sample which is immune to contamination. The entire system allows high confidence in the analysis, even if only a relatively small number of tracer particles are present.

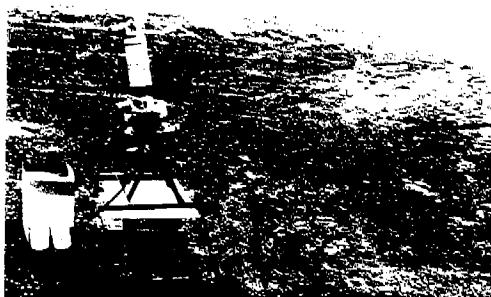
The extreme sensitivity of the FP tracer method allows the labeled air masses to be followed to great distances. Since assessment is based on the number of tracer particles found at a given location, the mass of tracer material collected need not be great. If ten particles are considered as a minimum significant number, this could correspond to as little as one part in 10^{14} of a typical source or approximately 10^{-4} micrograms of tracer per cubic meter of air for a typical sampling period.

TEST DESIGN

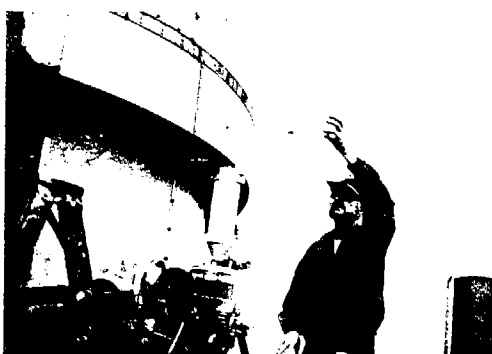
Different tracers were emitted into air masses at ground level in three areas of the Los Angeles Basin: Downtown Los Angeles, Torrance and Santa Ana, and from an elevated source in the Long Beach area (Page 19). The ground-level releases were intended to simulate motor vehicle pollutants and the elevated source to simulate industrial pollutants. The availability of distinctly different tracer materials allowed concurrent release and direct comparison of the different source areas in the same time frame.

Tracers were emitted during the morning hours at appropriate locations in a given source area. In the 1973 test series, tracer was emitted from aerosol generators at four fixed locations set four miles apart in a roughly square array within a defined source area (Page 19). This procedure contrasts with the 1972 series in which the aerosol generators were mounted on trucks and tracer was emitted while the truck

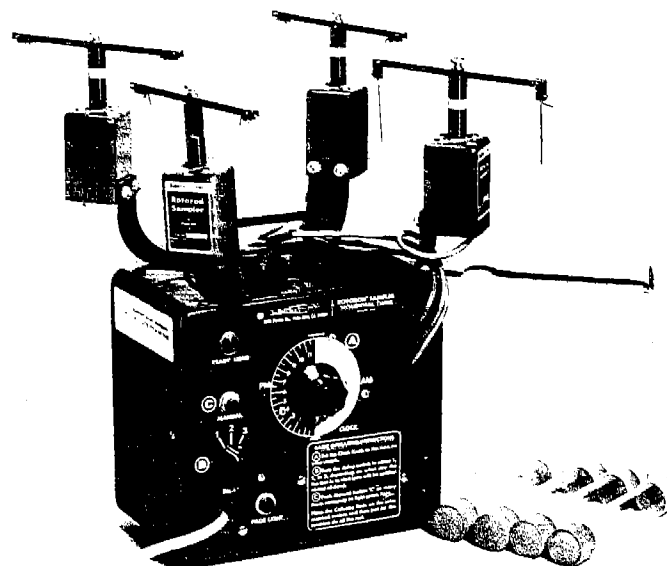
*Rotorod® is a registered trademark of Metronics Associates, Inc.



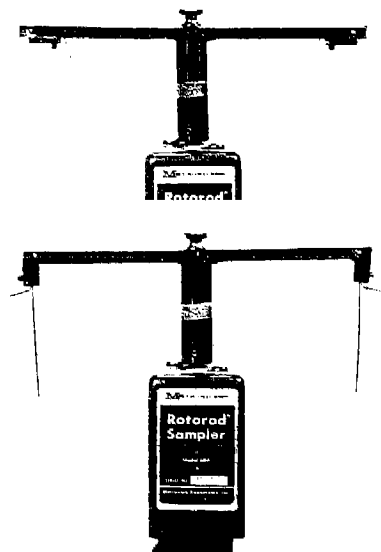
Aerosol Generator in Operation, Ground Level Source



Aerosol Generator in Operation, Smoke Stack Source



ROTOROD Sampler



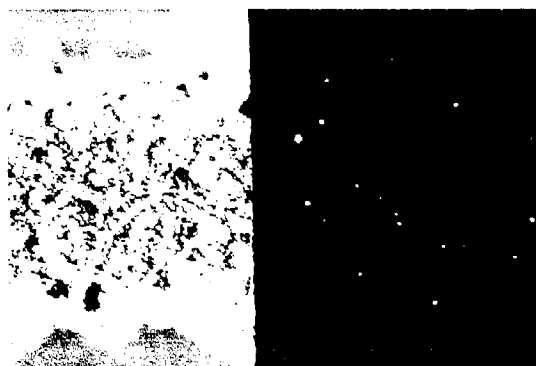
Collector Rods Retracted and Extended



Slide-Mounting Collection Surfaces



Visual Assessment



Normal vs. UV Illumination of a Collection Surface

traveled a perimeter defining the source area. The stationary mode of emission provided a more uniform source since it eliminated time delays and asymmetry caused by varying traffic problems.

The sampling network was extensive (Page 19). As an illustration of scale, Page 20 shows the portion of the South Coast Air Basin studied and the outline of several major cities for comparison.

Background samples were taken at thirty locations in the South Coast Air Basin before the test series was begun, in order to insure there were no interfering substances in the area. Small amounts of an orange fluorescent substance were found, but the color was easily distinguishable from any of the tracer colors employed.

A Rotorod air sampling network was used to sample the labeled air masses for 36 hours in the 1973 test series. Integrated samples were taken over three-hour periods for the first twelve hours and six-hour periods for the remaining twenty-four. This schedule represents a change from the 1972 test series, which used six-hour sampling periods for a total of 48 hours. It was felt that the three-hour sampling periods provided finer resolution during the first day of a test. By the second test day the tracer clouds were so dilute and widespread that six-hour samples proved sufficient.

METEOROLOGICAL CLASSIFICATION

WIND STREAMLINE MAPPING

Wind streamline maps were drawn for each tracer sampling period. Hourly wind measurements were averaged over the time interval corresponding to tracer sampling periods and plotted for each test. During daylight hours, a number of pibal stations were used in conjunction with the extensive surface station network in the Basin to provide values representative of the wind in the mixing layer. The resulting maps are printed adjacent to the Effective Tracer Concentration Maps in the sections devoted to specific tracer test results.

TABLE 1

COLLECTION EFFICIENCY OF ROTOROD SAMPLERS WITH TRACER MATERIALS USED IN FIELD TESTS			
Lot	Color	Particles/Gram	Rotorod vs. Membrane Filter Efficiency*
MLS-741	Blue	0.84×10^{10}	.40
MLS-748	Green	1.58×10^{10}	.26
MLS-736	Red	2.23×10^{10}	.37
MLS-740	Yellow	1.92×10^{10}	.35
*The membrane filter is assumed to be 100% efficient for particles in this size range			

STATION LOCATION MAPS

MACROTRON 19

AIR TRACER
SAMPLING
STATIONS

SURFACE
WIND STATIONS

AIR QUALITY
MONITORING
STATIONS

UPPER
AIR STATIONS

TIMES ARE PACIFIC STANDARD TIME

Map Grid - Universal Transverse Mercator Grid - 10,000 Meters

● AIR TRACER SAMPLING STATION

► SURFACE WIND SPEED AND DIRECTION

■ AIR QUALITY MONITORING APCD STATION

◆ AIRCRAFT OBSERVATIONS

⊙ PIBAL

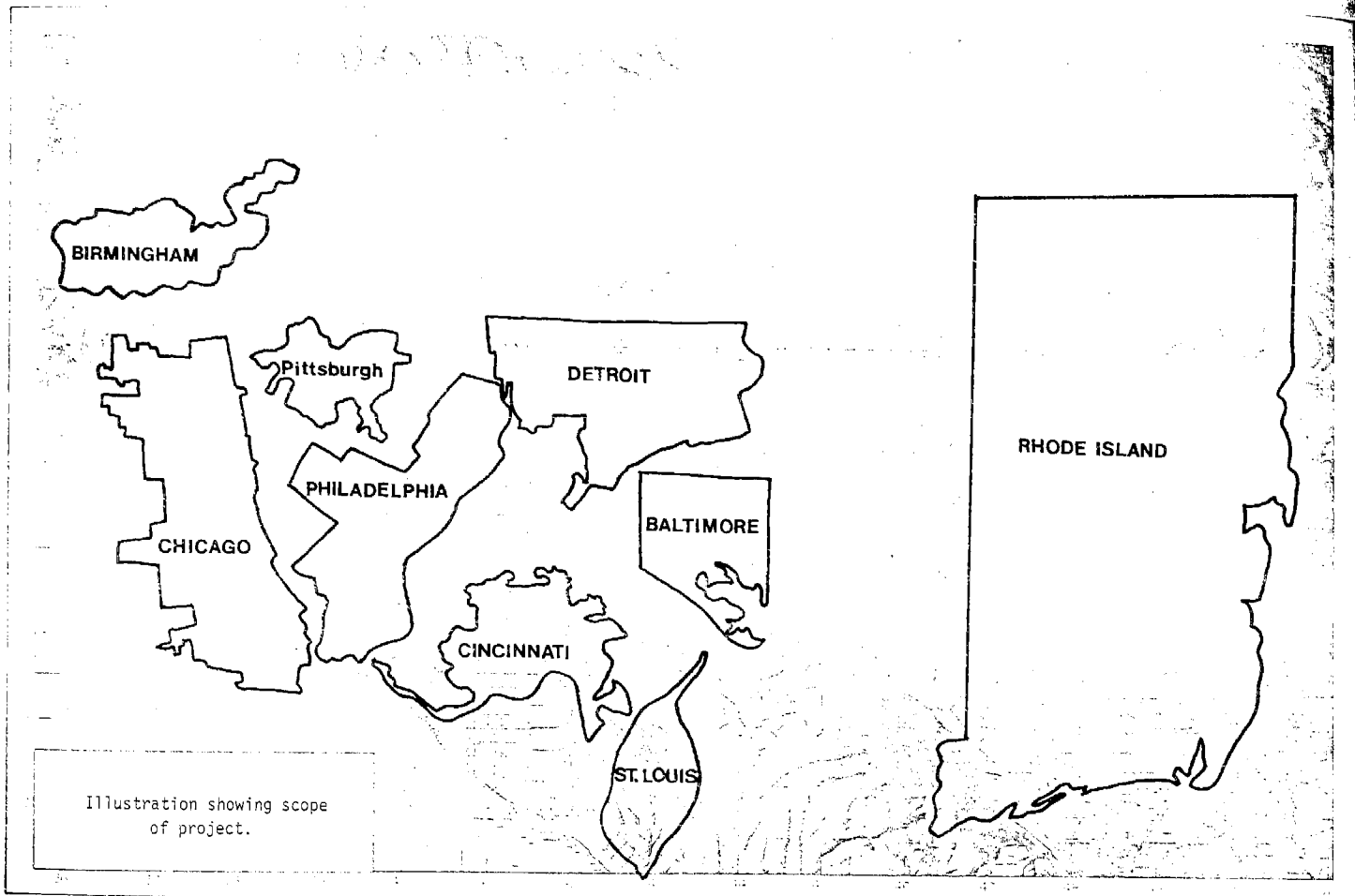
■ RAWINSONDE

▨ GROUND LEVEL TRACER SOURCE AREA

★ ELEVATED TRACER POINT SOURCE

0 5 10 20 30
Map Scale in Miles





MIXING HEIGHT CONTOURS

Mixing height contours were based on temperature soundings by Meteorology Research Inc. aircraft, supplemented by rawinsonde flights from Los Angeles International Airport (LAX), and El Monte and aircraft soundings by DASIBI at Flabob Airport in Riverside. Maps were drawn for an average of ten data collection points. When aircraft soundings were not available, mixing height was estimated from observations of cloud height. Several test periods had insufficient data for any contours to be drawn due to poor flying conditions. Maps of mixing heights on test days are printed in the sections devoted to specific tracer test results.

POLLUTION POTENTIAL

Tests were scheduled primarily for days when meteorological conditions were expected to be consistent with typical air pollution patterns; i.e., low mixing heights, clear skies and onshore winds in the afternoon.

A classification scheme was developed to relate oxidant levels in the South Coast Air Basin with objective meteorological parameters. Using meteorological parameters reduces errors introduced by the changing composition and amounts of pollutant emissions. For example, it has been recognized that automotive emissions on weekends do not follow the usual workday pattern, and pollution levels may be lower than meteorological conditions would warrant. By using meteorological classification, a given test day could be assigned a rating which would describe its pollution potential relative to long term averages. In this way the results of a tracer test can be applied to a class of days with a certain statistical frequency, rather than being restricted to the individual set of conditions extant that particular day.

The 0000 hrs. (Greenwich time) rawinsonde records taken at Santa Monica between 1956 and 1965 were chosen as the primary data base. This was done for two major reasons. The 0000 hr. Greenwich time corresponds to 1600 hours local standard time and this time was considered more representative of the conditions existing during the time of day when

oxidant levels and the transport of pollution are near their peak. Secondly, the data was available in a form (magnetic tape) readily amenable to computer processing.

Correlation with oxidant levels was based on a three-year period (1963-1965) which overlapped computer records of air quality in the South Coast Basin. Eighteen meteorological parameters were investigated for correlation with oxidant concentrations recorded at monitoring stations scattered throughout the Basin. Initially a simple correlation matrix for all parameters was calculated. (Table 2).

Several graphical analyses were performed to determine if any substantial improvement could be obtained by combining several parameters in the correlation (Appendix B).

It was found that the temperature at the top of the inversion (TT) was the best single parameter used to classify the pollution potential of the days studied. The accuracy of the classification could be improved slightly by including the parameters: "height of the inversion base" (HB), and "temperature difference through the inversion" (AT).

Maximum hourly oxidant (OX) records from monitors at Anaheim, Riverside, San Bernardino, Ontario, Los Angeles, Azusa, Burbank, and Pasadena were averaged to provide three categories of pollution level.

Low	OX < 10 ppbm
Moderate	10 ≤ OX ≤ 20 ppbm
Heavy	OX > 20 ppbm

Averaging over the entire Basin has some drawbacks. A generally lower range of values is obtained, and it is sometimes difficult to distinguish stagnant conditions (resulting in high values in the western Basin and low values to the east) from strong transport (resulting in low values in the western Basin and high values to the east). However, the system provides a single value indicative of the pollution level in the Basin as a whole.

The three meteorological parameters chosen as classifiers were used as follows:

Pollution potential was classified High if TT > 24.0°C, and HB < 400 m, and AT > 8.0°C.

TABLE 2

CORRELATION MATRIX OF METEOROLOGICAL PARAMETERS AND AVERAGE OXIDANT CONCENTRATION

[illegible]

Pollution potential was classified Low if there was no measurable inversion or if $TT < 18.0^{\circ}\text{C}$ and $AT < 4.0^{\circ}\text{C}$.

Pollution potential was classified Moderate for the other possible conditions.

Applying this system to the data base constructed from records covering June through November, 1963 through 1965, the following results were obtained:

TABLE 3
ACCURACY OF POLLUTION POTENTIAL CLASSIFICATION

Classified Low	196
Actually Low	146
Classified Moderate	220
Actually Moderate	268
Classified High	105
Actually High	107
Not Classified (Missing Data)	28

The accuracy of classification for frequency of occurrence is seen to be fairly good. The accuracy of the particular classification of any given day is somewhat lower and averages approximately 65%. The difference in accuracy is due to errors in classification being rather uniformly distributed and hence cancelling out when only total frequency of occurrence is considered.

Based on a 10-year data base (1956-1965), the frequency of occurrence of the pollution potential classes for summer and fall months is as follows:

Low	22%
Moderate	52%
High	25%

Tables presenting the maximum hourly average oxidant concentration and tables listing pollution potential parameters and Pasquill stability classes for test days in 1972 and 1973 are presented in the SUMMARY Section on Pages 97 and 98.

WIND FLOW

In addition to pollution potential, the overall wind flow should also be considered in the meteorological classification. However, a complete statistical classification of all wind trajectory patterns in the South Coast Air Basin is beyond the scope of this report. Under a given pollution potential regime several variations in wind patterns are possible. The variability of wind flow is most apparent in the early morning hours and can have a noticeable influence on the specific trajectory a labeled air mass will follow. As described in the section on Test Design, release times for the 1973 test series were chosen to expose the tracer cloud to the predominant onshore wind flow pattern for a moderate pollution potential day and to minimize early morning variability.

Table 4 lists the frequency of occurrence of wind directions by month and time of day for two locations in the South Coast Air Basin. The wind streamlines for the entire Basin for each sampling period during a test are presented in the sections devoted to individual test results.

COMPARISON OF FP TRACER WITH POLLUTANTS

LIMITS OF COMPARISON

FP tracer most closely simulates a relatively non-reactive pollutant such as carbon monoxide (CO). Carbon monoxide is generally considered stable in the atmosphere and losses during transport above ground level are low. FP tracer is likewise non-reactive and losses due to fallout or impaction on vegetation are minimal during transport after the first few hundred yards (Leighton et al 1965).

The CO concentration equivalent to an effective tracer concentration can be calculated by comparing the known tracer source strength with the estimated CO production in the corresponding source area. Using the unique tracer eliminates uncertainty concerning relative contributions of local sources since the exact location and time of the tracer emission is defined.

TABLE 4

RELATIVE FREQUENCY OF WIND DIRECTION AT LOS ANGELES AND SAN BERNARDINO BY TIME OF DAY

DIRECTION	0600-0900		0900-1200		1200-1500		1500-1800		0600-0900		0900-1200		1200-1500		1500-1800	
	%	MEAN WIND SPEED	%	MEAN WIND SPEED	%	MEAN WIND SPEED	%	MEAN WIND SPEED	%	MEAN WIND SPEED	%	MEAN WIND SPEED	%	MEAN WIND SPEED	%	MEAN WIND SPEED
LOS ANGELES (1947-1964) - AUGUST									LOS ANGELES (1947-1964) - SEPTEMBER							
N	2.3	3.5	.5	3.9					2.8	2.9	.4	3.0				
NNE	1.3	2.8	.3	2.6					2.1	3.3	.3	3.4				
NE	2.6	3.1	.5	3.6	.1	7.0	.1	2.0	4.0	3.7	1.2	3.7			.1	4.5
ENE	4.9	3.4	.8	4.7	.1	3.0			6.3	3.0	1.2	5.3	.2	10.0		
E	9.1	3.9	1.1	3.6	.1	7.0			10.4	4.2	2.3	5.2	.1	10.5	.1	8.5
ESE	7.3	4.3	2.2	5.0	.2	8.7	.2	9.7	7.8	4.3	3.7	5.1	.2	8.8	.1	4.0
SE	9.7	4.2	3.7	4.9	.2	8.5	.1	5.0	7.7	4.2	4.6	4.9	.2	9.5	.1	7.0
SSE	6.2	3.8	4.4	4.8	.2	6.3	.1	7.5	4.1	3.6	3.8	4.8	.4	6.0	.1	7.5
S	5.4	3.4	3.0	4.4			.1	4.0	4.4	3.5	4.4	4.3	.2	4.7	.1	2.0
SSW	3.9	3.4	2.7	5.2	.2	9.0	.2	7.0	2.6	4.0	3.7	4.9	.6	9.4	.1	9.5
SW	4.6	3.4	13.3	6.2	7.0	9.1	3.0	8.6	2.3	3.3	11.7	6.1	8.3	9.1	5.0	8.5
WSW	6.3	4.4	38.6	7.3	52.0	9.9	48.1	10.4	5.2	4.3	30.7	7.2	50.1	9.8	45.9	9.8
W	8.8	4.4	19.8	7.2	35.5	10.6	44.4	11.0	5.6	4.5	20.5	7.1	34.6	10.6	42.6	10.4
WNW	3.4	3.8	4.8	6.0	4.2	8.6	3.5	9.2	4.3	4.0	5.4	5.7	4.4	8.2	5.2	8.0
NW	2.7	3.3	.8	5.4	.2	8.5	.3	7.4	3.6	3.2	.9	4.5	.4	7.7	.5	7.9
NNW	2.3	3.0	.4	4.0					2.5	3.2	.6	2.9	.1	2.0		
VARBL CALM	19.3		3.0						24.3		4.6				.1	
	100.0	3.1	100.0	6.3	100.0	10.0	100.0	10.5	100.0	3.0	100.0	6.0	100.0	9.9	100.0	9.9
SAN BERNARDINO (1943-1966) - AUGUST									SAN BERNARDINO (1943-1966) - SEPTEMBER							
N	1.2	3.3	.9	2.9	.3	6.6	.0	5.0	1.3	4.0	1.2	5.5	1.4	8.4	1.0	10.5
NNE	.7	3.9	.2	3.0	.1	2.0	.1	6.5	1.0	5.4	.9	7.7	.9	8.7	.5	16.4
NE	1.2	2.9	.1	2.0	.1	4.7	.1	3.5	2.5	2.9	.7	4.6	.4	5.6	.3	7.6
ENE	1.3	3.0	.3	3.8	.1	12.5	.1	10.0	1.9	3.2	.3	3.7	.1	9.0	.2	8.4
E	3.1	3.2	.3	5.7	.2	13.3	.4	8.3	5.1	3.7	.7	5.7	.7	6.6	.4	9.8
ESE	1.6	3.9	.4	5.3	.1	7.0	.1	17.5	3.1	3.7	.5	5.4	.6	8.2	.7	10.6
SE	1.7	2.7	.4	2.9	.3	6.7	.4	8.3	3.0	3.5	.4	4.6	1.1	7.8	.7	6.6
SSE	.7	2.7	.2	4.2	.2	8.3	.1	9.3	.8	3.1	.6	4.4	.7	6.8	.5	6.2
S	1.2	3.0	.7	3.8	.4	7.4	.2	8.4	1.1	2.4	1.3	4.7	1.4	5.6	1.0	7.5
SSW	1.2	2.9	2.1	3.6	3.3	6.5	2.1	7.5	.6	2.9	1.7	4.2	3.4	6.2	2.6	7.2
SW	2.5	3.4	12.3	4.7	21.1	7.0	23.3	8.9	1.9	3.2	8.1	4.2	18.3	6.9	21.0	8.0
WSW	1.7	3.8	13.4	4.8	30.7	7.7	44.7	9.5	1.3	3.3	10.1	4.8	24.2	7.4	37.9	9.0
W	2.1	3.3	16.2	4.7	25.8	7.3	24.4	9.2	1.9	3.6	12.9	4.4	23.6	7.0	25.3	8.5
WNW	1.0	3.0	5.9	4.2	7.0	6.6	1.9	8.4	.4	2.9	6.1	3.9	7.5	6.2	3.3	7.8
NW	1.3	3.2	6.1	4.0	2.5	6.0	.4	6.8	.8	3.0	5.3	4.1	5.1	5.9	1.3	5.8
NNW	.6	3.4	1.3	3.7	.4	3.6			.6	4.8	1.8	5.4	1.3	6.8	.5	6.8
VARBL CALM	76.8		39.2		7.3		1.7		72.7		47.3		9.3		2.6	
	100.0	.8	100.0	2.7	100.0	6.7	100.0	9.0	100.0	1.0	100.0	2.4	100.0	6.3	100.0	8.3

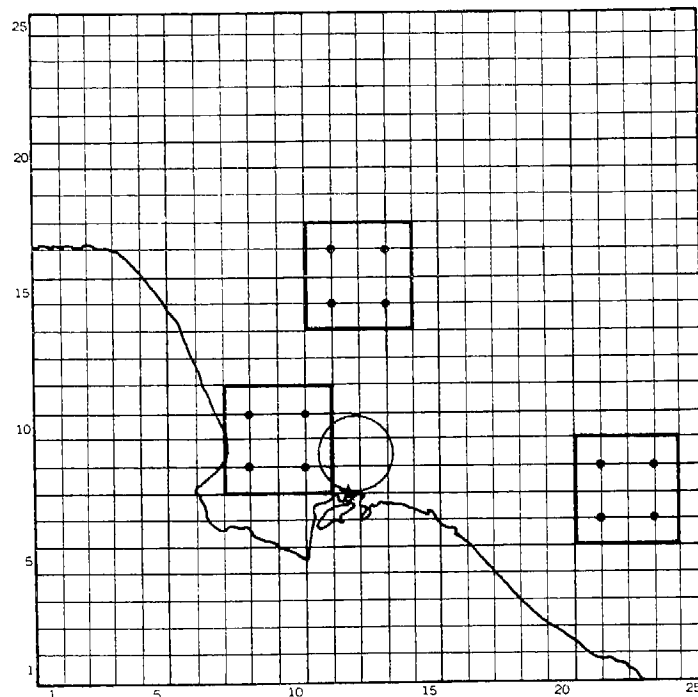
FP tracer can be used effectively to simulate industrial emissions such as SO_2 . Tracer material is chemically stable enough to allow its emission directly up the same stack being used for effluents. Reactions of SO_2 in the environment act to decrease ambient concentration and so quantitative estimates can be derived from comparisons with FP tracer by application of a decay factor.

The FP tracer method can be used to define the transport of reactive secondary pollutants but not to give quantitative estimates of their concentration. The concentration of reactive pollutants such as ozone is a complex function of many factors. The chemical makeup and concentration of such pollution in the air will vary with time because the level is the result of a dynamic equilibrium and small changes can easily shift the overall chemical structure.

AUTOMOTIVE EMISSIONS

In order to relate the measured FP concentrations from each ground-level source area to automobile emissions from the same area, the total emission of carbon monoxide was estimated for each 8-mile square represented by the FP tracer dispersal. The source areas were chosen to correspond to sections of the vehicle emissions grid used by Roberts et al (1971).

Vehicle-miles for freeways and surface streets were also obtained from Roberts et al (1971). Average vehicle speeds on freeways in the slow and fast directions were obtained from Roberts, et al (1972). Average vehicle emissions of CO were obtained from the EPA compilation (1973). The basic emission value for a speed of 20 mph was 62 grams per mile and this figure was used for all non-freeway emissions. Speed corrections were used for freeway emissions. The calculated total emissions of CO from each source area are given in Table 5 for the time periods 0700-1000 PDT (corresponding to the FP tracer dispersal in Test A) and 0700-1200 PDT (corresponding to the tracer dispersals in Tests B and C).



EMISSIONS INVENTORY GRID

Longitude	West	118°	38'	15"
	East	117°	46'	3"
Latitude	North	34°	17'	30"
	South	33°	34'	2"

The area is divided into 625 grid squares, each 2 miles x 2 miles.

Large squares show ground level tracer source areas; circle shows the modeled industrial source area; heavy dots indicate actual tracer emission points.

Roberts, Roth and Nelson: Contaminant Emissions in the Los Angeles Basin--Their Sources, Rates and Distribution: Appendix A. Report prepared for the Air Pollution Control Office of the Environmental Protection Agency, CPA 70-148 (1971).

TABLE 5
CARBON MONOXIDE EMISSIONS FROM URBAN
SOURCE AREAS

Source Area	Time (PDT)	CO Emissions (Kg)		
		Freeway	Non-Freeway	Total
Los Angeles	0700-1000	37,500	65,500	103,000
	0700-1200	56,500	106,000	162,500
Torrance	0700-1000	9,800	44,600	54,400
	0700-1200	14,800	72,000	86,800
Santa Ana	0700-1000	9,100	33,700	42,800
	0700-1200	13,700	54,500	68,200

The total CO emissions from each source area can be expressed in an equivalent number of tracer particles (e.g., micrograms CO/tracer particle). Later, when we determine the effective concentration of tracer particles in terms of particles per cubic meter at a given site, a direct conversion to CO concentration is easily accomplished. In practice, it is convenient to include the correction factor for the less than perfect Rotorod collection efficiency at this step of the calculations. The number of tracer particles from a given source is corrected for relative collection efficiency and normalized to a value of 5×10^{14} particles for each source. The resulting equivalent CO concentrations are given in Table 6.

TABLE 6
CARBON MONOXIDE CONCENTRATION EQUIVALENT
TO AN FP TRACER CONCENTRATION

Source Area	Time (PDT)	CO Concentration (ppm)
		Equivalent to 1 FP/m ³
Los Angeles	0700-1000 (Test A)	1.80×10^{-4}
	0700-1200 (Tests B and C)	2.84×10^{-4}
Torrance	0700-1000 (Test A)	0.96×10^{-4}
	0700-1200 (Tests B and C)	1.52×10^{-4}
Santa Ana	0700-1000 (Test A)	0.76×10^{-4}
	0700-1200 (Tests B and C)	1.20×10^{-4}

To determine the CO concentration represented by a given tracer contour, multiply the tracer contour value by the appropriate factor given above. The resulting number is the effective CO concentration in parts per million.

From Table 6 and the effective tracer concentration maps presented in the sections devoted to specific tests, it is evident that carbon monoxide concentrations outside the Los Angeles Basin are primarily a result of local or nearby emissions. The three ground-level source areas chosen represent approximately 20% of the total CO emissions in the Los Angeles Basin, but even if the equivalent concentrations in Table 6 were multiplied by five, the highest equivalent CO concentration outside the Basin from any of these source areas would still be less than 1 ppm.

INDUSTRIAL EMISSIONS

The elevated source near Long Beach was a stack of the Harbor Steam Plant of the Los Angeles Department of Water and Power. This source was used to represent emissions from industrial sources in the area. The Harbor Steam Plant emits only two tons of SO₂ per day, which is about one-sixtieth of the total from ten industrial sources. These sources include four chemical companies, five oil refineries, and the Harbor Plant (Los Angeles County Air Pollution Control District Report-1973). The sources are within a five-mile diameter circle centered approximately two miles north of the Steam Plant. If the total emissions per day of sulfur dioxide and oxides of nitrogen from industrial sources in this area are considered together, the Long Beach source represents 121.7 ton of SO₂ and 30.3 tons of NO_x. Using the same method of calculation as used to compute equivalent automotive CO concentrations, the conversion factors for industrial pollutants equivalent to one tracer particle/m³ are 1.80×10^{-5} ppm of SO₂ and 0.62×10^{-5} ppm of nitrogen oxides expressed as NO₂, with no provision for decay enroute.

NORMALIZED OXIDANT MAPPING

Oxidant concentration is generally used as the primary indicator of the pollution level in the South Coast Air Basin. Accordingly, a parameter related to the oxidant concentration was used to indirectly compare pollutants with the transport of tracer materials. It was found that a simple plot of the concentration of oxidant as a function of time was strongly influenced by the generally higher concentrations found in both the eastern Basin and along the base of the San Gabriel Mountains. These high values often masked the relative changes occurring in the area.

In order to provide a sensitive measure of changes in the overall oxidant pattern, a double normalization was employed. First, the hourly average oxidant concentration at a monitoring station, for a given time, was expressed as a fraction of the maximum concentration reached at that station during that day. Second, this value was re-expressed as a fraction of the average of all such values reported Basin-wide in the given time period.

A deviation index "D" is thus defined:

$$D = \frac{A/M}{B} \text{ where,}$$

A = Oxidant concentration at a given station

M = Maximum concentration at that station for that day

B = Basin-wide average of all A/M's for each mapping period

In practice, the hourly values of oxidant concentration corresponding to the three-hour tracer sampling periods were averaged to provide a single value representative of the entire period. For convenience in calculation, this value was then expressed as a fraction of the maximum hourly concentration of the entire day, for that station, as listed in the standard air quality reports. Each of these normalized values was then represented as a fraction of the Basin-wide average of such values for the three-hour sampling period.

The results of plotting this deviation index bear a strong resemblance to tracer test results but have a number of limitations. The

method can only be used satisfactorily when the oxidant levels are appreciably above threshold values of detection. Since the oxidant concentration follows a diurnal pattern, meaningful results can only be expected for daylight hours. Unlike tracer results, factors other than advection can have a strong influence on the resulting maps. Variations in continuing emissions and chemical reactions are very important. However, if we can assume that the rates of automotive and industrial emissions follow roughly the same time schedule all over the Basin and that insolation and chemical composition are also relatively uniform, the transport and diffusion of polluted air become the major factors in the resulting pattern.

If the above assumptions of uniformity are valid and the situation was such that there was no transport all day, each station should reach the same fraction of its daily maximum at approximately the same time and the deviation index would be equal to unity at all stations for all time periods. When transport does occur, the actual normalized oxidant concentration at a given station should differ from the Basin-wide average.

In low emission downwind areas, before transport begins, the oxidant concentration will be lower than expected from an average concentration profile with the same maximum. That is, the downwind area will have achieved a smaller fraction of its maximum value than the average station in the Basin at that time. Thus, the deviation index will be less than unity. When transported pollution arrives, the difference from the average profile will be positive and the deviation index will become greater than unity.

Conversely, in high emission upwind areas, the actual normalized oxidant concentrations, before transport begins, will be higher than expected from the average profile. That is, the area will have achieved a larger fraction of its maximum value than the average station in the Basin at that time. When advection of clean air into the area begins, the deviation index will become less than unity.

There are several other combinations of positive, negative, and zero departures from average which depend on the time when transported

pollution arrives in relation to the time the Basin-wide average of normalized concentrations reaches its maximum value. The normalized oxidant maps presented on Pages 50, 72, and 96 are examples of situations on test days favoring transport in the South Coast Air Basin.

The normalized oxidant method of presenting differences in oxidant concentration profiles can point out whether the oxidant pattern is consistent with mechanisms involving transport or whether other factors are dominant. In cases where transport is not a dominant factor, the method still provides a graphic way to describe differences in oxidant patterns over a large area. In cases where transport is the dominant factor, the method shows differences in transport patterns from day to day and may be used to illustrate such patterns using data which is currently being collected routinely. Further study of applications of this technique are currently planned.

Test A, 3-4 August 1973

METEOROLOGY

SYNOPTIC WEATHER

On the morning of 3 August the Pacific high was centered at 45° north latitude and about 300 miles west of the Washington Coast (Page 31). A thermal low was centered in the southeastern part of the state providing a moderate onshore pressure gradient. A low pressure trough in the upper air pattern provided a southerly flow bringing moisture into the area and causing thunderstorms in the mountains and high desert areas.

By the morning of 4 August a weak cold front was approaching the Washington Coast and the upper trough off Northern California had moved over the coast and the thermal low had expanded over the Sacramento-San Joaquin Valley.

LOCAL WEATHER

There were scattered clouds between 10,000 and 20,000 feet over most of the Basin with low-level fog and stratus over the entire plain by 0600 PST. Visibilities were generally less than four miles. Clearing began by 0900 PST and all areas except Torrance and Santa Monica were clear of fog and stratus by 1200 PST with thin clouds at about 12,000 ft. By 1500 PST stratus was entering the north coastal sector and there was an increase in high and middle level clouds. Visibilities were generally five miles or less in all areas except southern Orange County and the Riverside-Chino area where they were as high as twelve miles.

The morning soundings at Los Angeles International Airport (LAX) and El Monte (EMT) showed a temperature inversion of $9-10^{\circ}$ C with a base at about 300 m (1000 ft.). Flabob Airport near Riverside had a 7° C inversion based at 240 m (800 ft.). By midday the inversions at EMT and Flabob were reduced to $3-5^{\circ}$ C by heating of the surface layer. (Page 32).

Mixing heights were about 300 m (1000 ft.) in the morning increasing to 300-460 m (1000-1500 ft.) by midday in the Los Angeles Basin and

460-600 m (1500-2000 ft.) in the San Bernardino-Riverside area in the afternoon.

Winds were generally from the south to southeast in the mixing layer in the Los Angeles Basin in the morning, becoming southwesterly in the afternoon and westerly in the eastern Basin with wind speeds 10-20 knots by late afternoon.

By the morning of 4 August stratus and fog had spread over the entire area except the San Bernardino-Riverside area where broken clouds were reported at 7,000 ft. Visibilities were six miles or less in fog, haze and smoke. By midday the fog and haze had cleared all areas except Santa Monica and Torrance but scattered to overcast cloudiness prevailed with ceilings of 7,000 to 15,000 ft.

Winds were southerly in the Los Angeles Basin during the morning, becoming southwesterly in the afternoon and westerly in the eastern Basin with speeds from 8 to 20 knots.

Only one rawinsonde flight was made at LAX at 1130 PST (Page 33). The base of the inversion was at 600 m (2,000 ft.) and the top at 850 m (2,800 ft.). The temperature difference was 6° C. The aircraft soundings at Flabob Airport showed a 6° C inversion with the base at 240 m (800 ft.) during the morning and a 3° C inversion with base at 370 m (1200 ft.) by midday. Mixing heights were generally 460 to 600 m (1500 to 2000 ft.) throughout the area the second day.

Pollution potential was classified as Moderate.

DESCRIPTION OF TRACER RESULTS

Emission of tracer from the ground-level sources (Los Angeles, Torrance and Santa Ana) began at 0600 PST and continued until approximately 0900 PST. Emission at the elevated source at Long Beach was delayed. Emission at Long Beach was begun at 0900 PST, running until 1500 PST. The effective concentrations of the various tracers and the average wind streamlines corresponding to sampling periods are mapped on Pages 34 through 49.

LOS ANGELES SOURCE AREA

Tracer from the Los Angeles area moved northward into the San Fernando Valley during the morning, leaving only a small residual cloud which spread northwestward toward the Santa Monica Mountains and northeastward toward the San Gabriel Mountains. Concentrations dropped to levels below significant limits in the sampling area after 1800 PST.

TORRANCE SOURCE AREA

Tracer from the Torrance area moved primarily northward into the San Fernando Valley. A small portion of the tracer cloud was diverted along the base of the San Gabriel Mountains and moved eastward in low concentration as far as San Bernardino.

SANTA ANA SOURCE AREA

Tracer from the Santa Ana-Anaheim area moved predominantly north and east through the Santa Ana Canyon and over the Chino and Puente Hills. A smaller portion of the cloud was caught in a flow to the northwest and moved up to the base of the San Gabriel Mountains. Contrary to the results expected from the wind streamlines including those aloft, small amounts of tracer appeared in the Torrance area during the third sampling period (1200 to 1500 PST). Levels were barely in the significant range.

There was some question about the exact nature of the particles observed. However, the next sampling period shows movement of this dilute cloud in accord with the wind pattern indicating more than a transient phenomenon. Therefore, contour lines are drawn for these data. No other tracer test showed a similar pattern for the Santa Ana source.

LONG BEACH (elevated) SOURCE

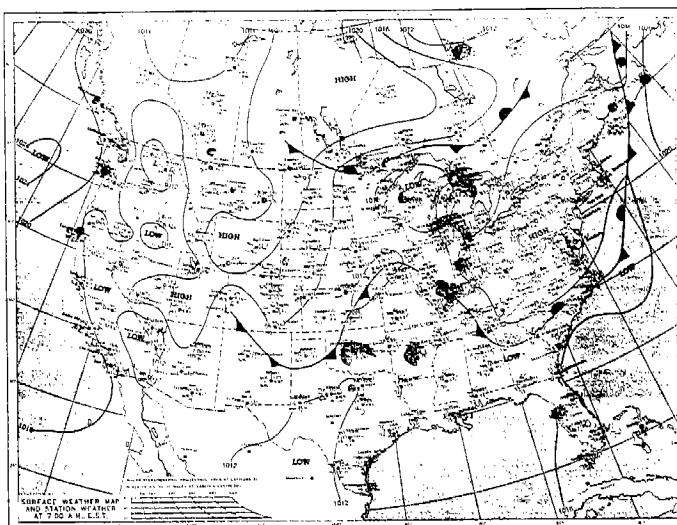
Emission of tracer from the power plant stack near Long Beach was run later in the day than the other sources (0900 to 1500 PST). Predominant movement of the tracer cloud was to the northeast and then east along the base of the San Gabriel Mountains. Later in the day a large portion of the tracer cloud lying along the base of the mountains started moving southeast toward the Riverside area. Relatively high concentrations

in this area were observed during the night as the winds died down. A small region around the source area also retained a portion of the cloud.

NORMALIZED OXIDANT

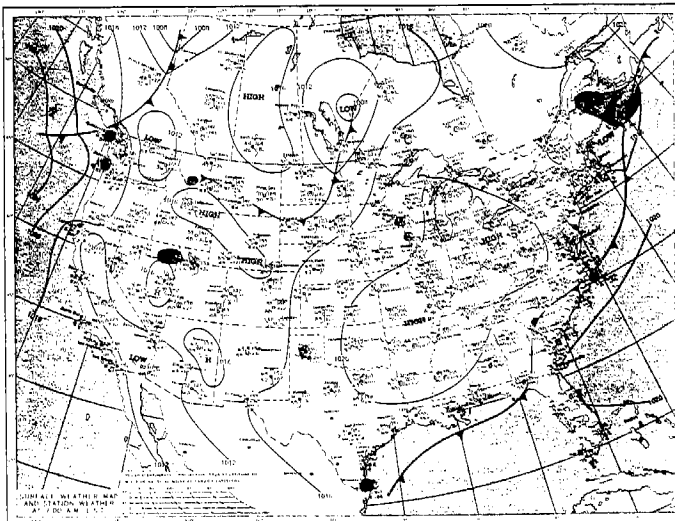
The Normalized Oxidant maps for the first twelve hours of the test day indicate a pattern consistent with transport of polluted air from west to east. The areas where the deviation index is greater than unity (in the western Basin and around the Riverside area) indicate early low production of oxidant. By afternoon, the region near the base of the San Gabriel Mountains and the major portion of the eastern Basin had increased relative levels of oxidant, while levels on the coastal plain had begun to decrease. The late afternoon pattern indicated an incursion of relatively clean air well into the Basin.

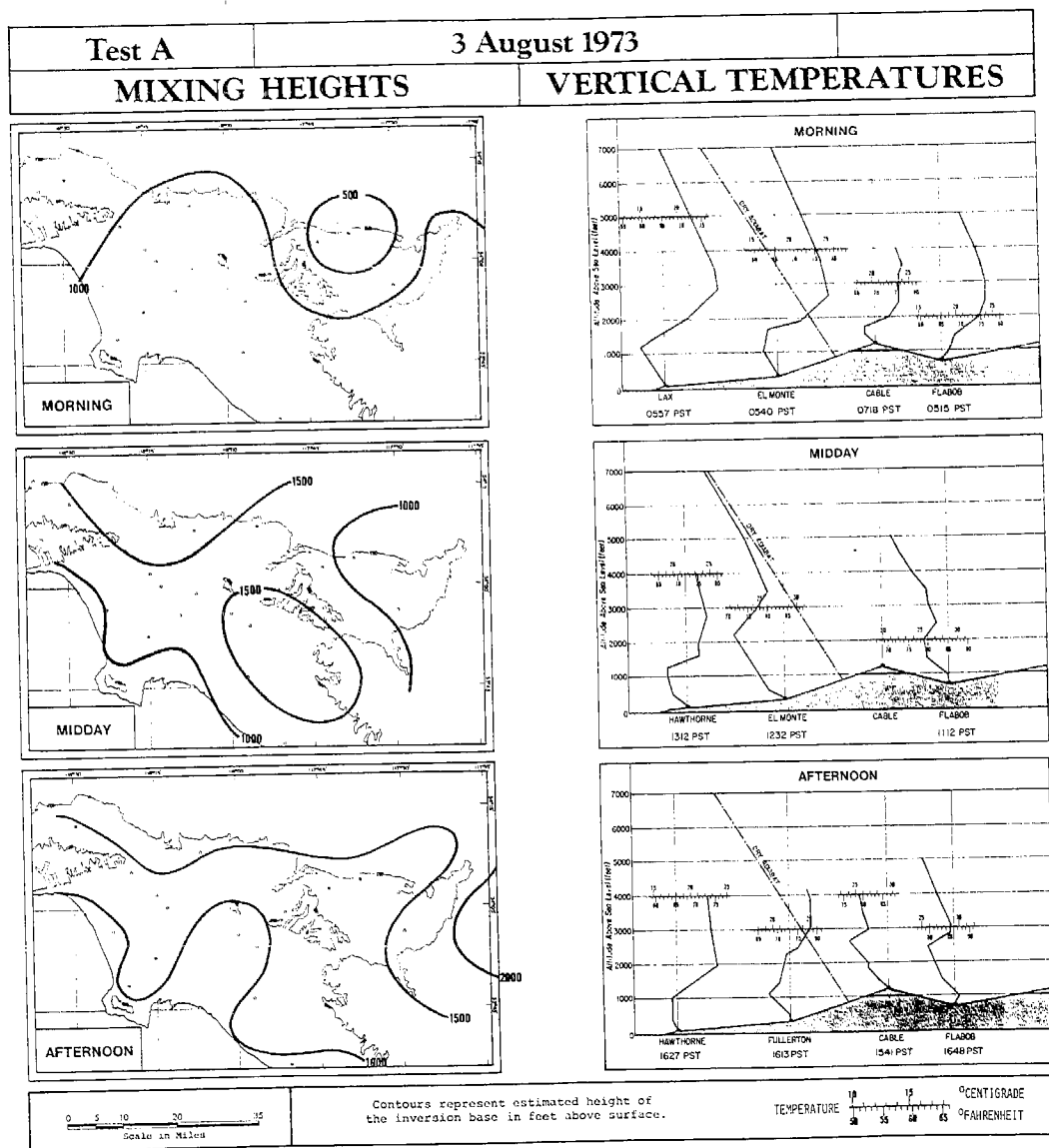
FRIDAY, AUGUST 3, 1973



Surface Weather for Air Tracer Test B at 4:00 A.M. PST on 3 and 4 August 1973

SATURDAY, AUGUST 4, 1973





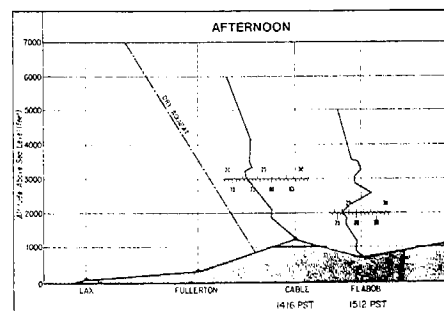
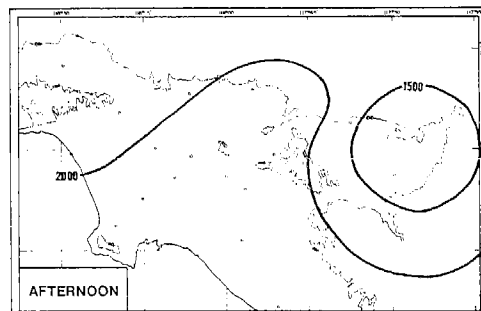
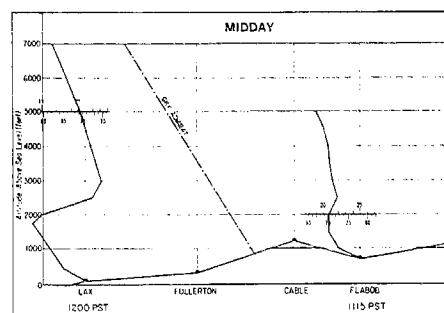
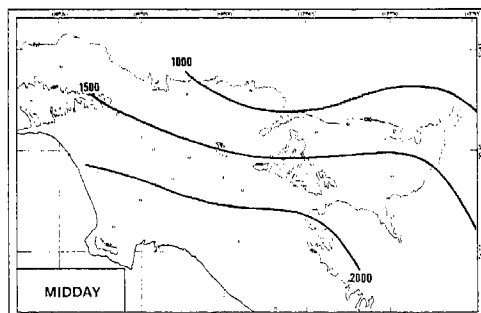
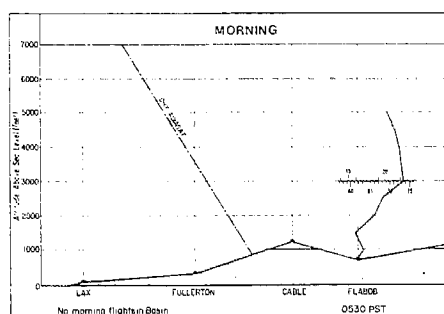
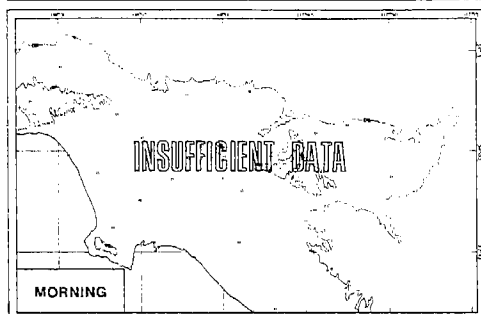
Test A

4 August 1973

MEADCOX 33

MIXING HEIGHTS

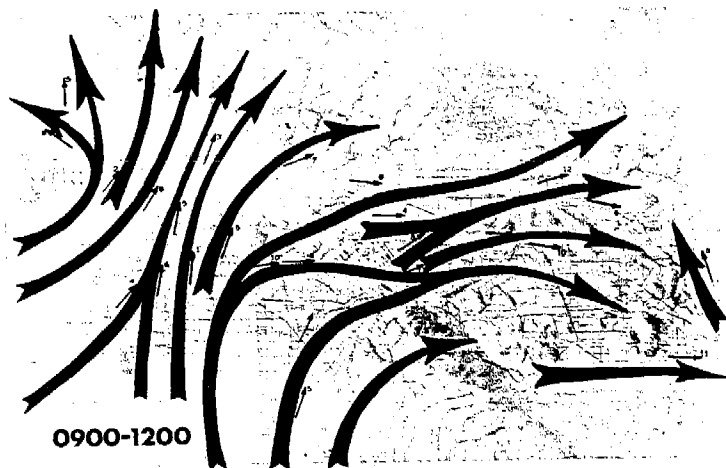
VERTICAL TEMPERATURES



0 5 10 20 35
Scale in Miles

Contours represent estimated height of the inversion base in feet above surface.

TEMPERATURE 10 15 °CENTIGRADE
50 55 60 65 °FAHRENHEIT



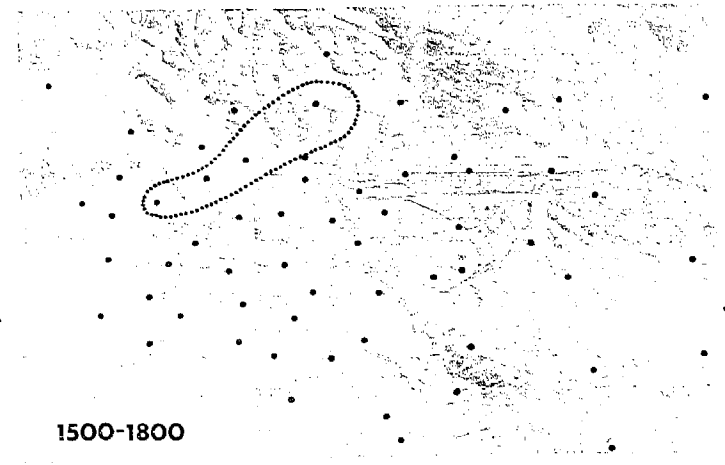
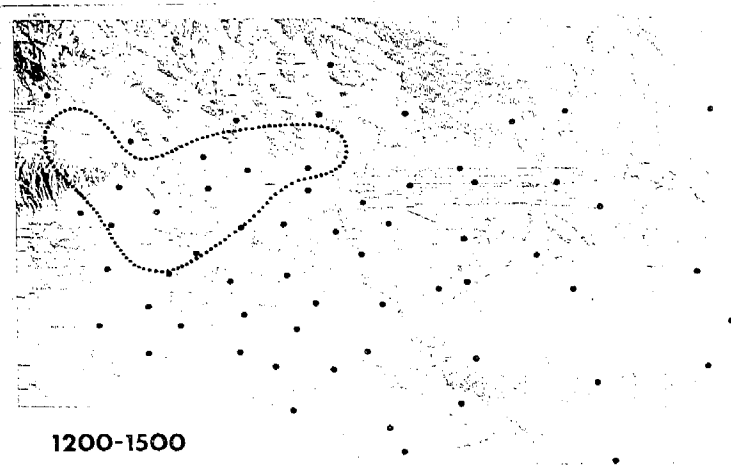
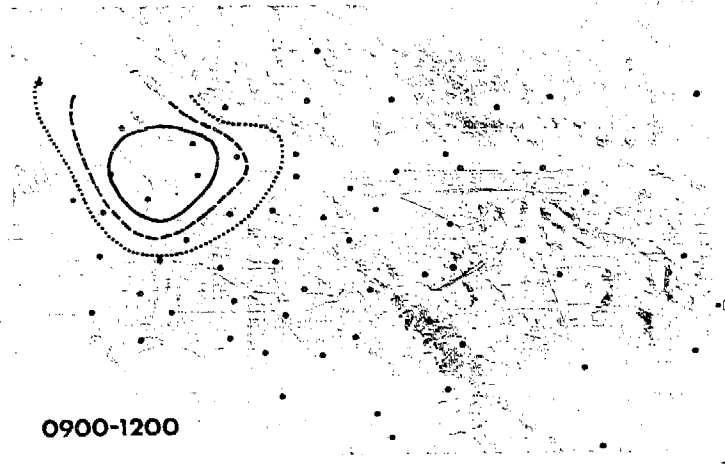
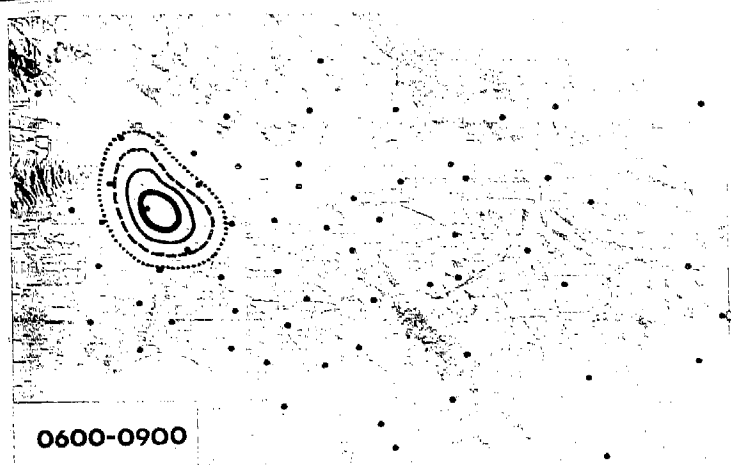
TIMES ARE PACIFIC STANDARD TIME
Map Grid - Universal Transverse Mercator Grid - 10,000 Meters

Wind vectors computed by averaging hourly values for the time periods noted. Both surface and Pibal measurements were used during the daylight hours.

0 5 10 20 30
Map Scale in Miles



Test A	3 August 1973	Effective Tracer Concentration	LOS ANGELES SOURCE	35
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<p>TIMES ARE PACIFIC STANDARD TIME.</p> <p>Map Grid - Universal Transverse Mercator Grid - 10,000 Meter</p>	<p>Contours represent an effective average concentration of tracer material from a normalized source of 5×10^{14} particles.</p> <p>..... 1* ——— 10 ——— 100 ——— 1000</p> <p>* Number of particles per cubic meter.</p>	<p>0 10 20 30</p> <p>Mile Scale in Miles</p>
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36



Test A

3-4 August 1973

Average Wind Streamlines in the Mixing Layer

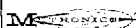


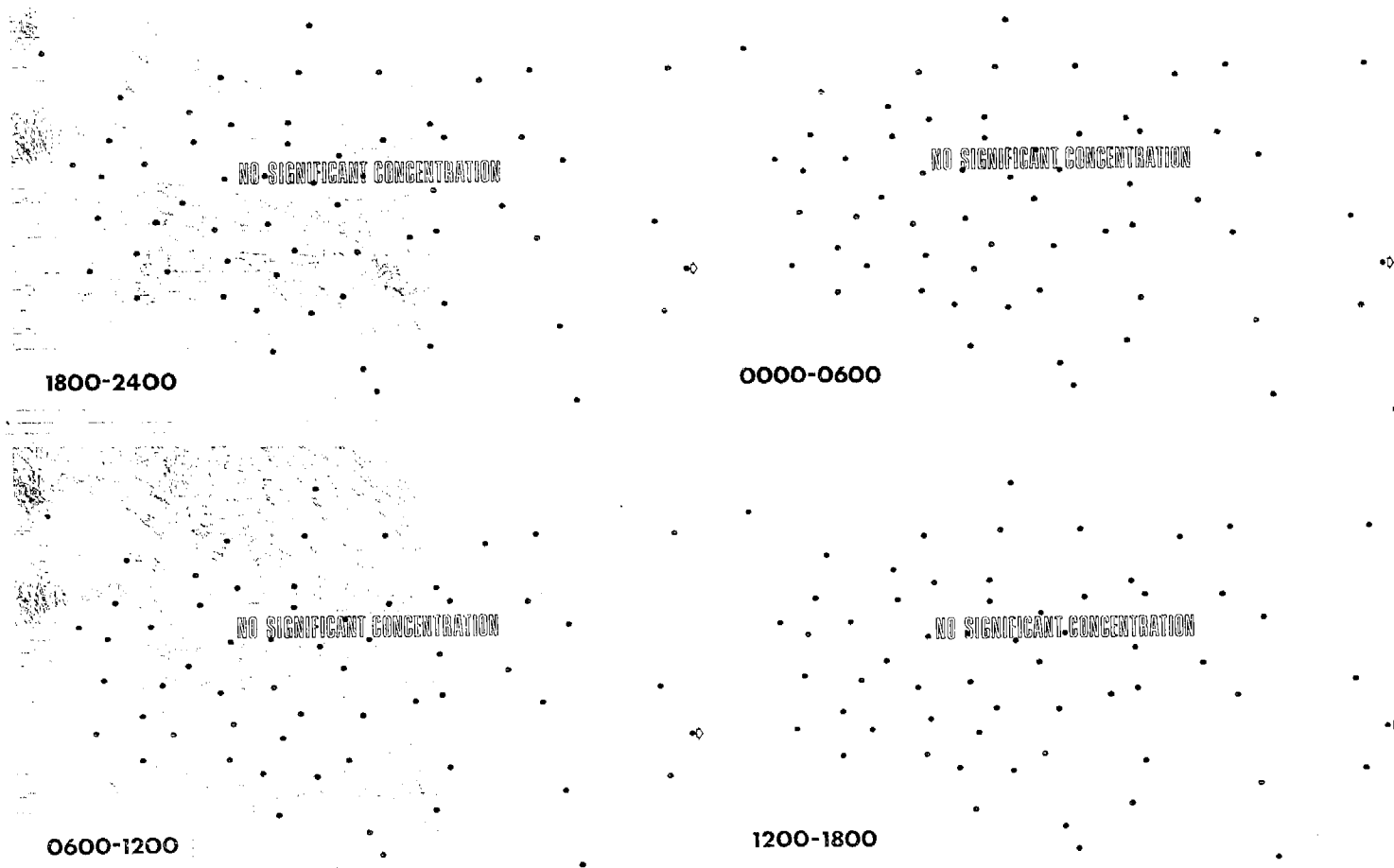
TIMES ARE PACIFIC STANDARD TIME
Map Grid - Universal Transverse Mercator Grid - 10,000 Meters



Wind vectors computed by averaging hourly values for the time periods noted. Both surface and Pibal measurements were used during the daylight hours.

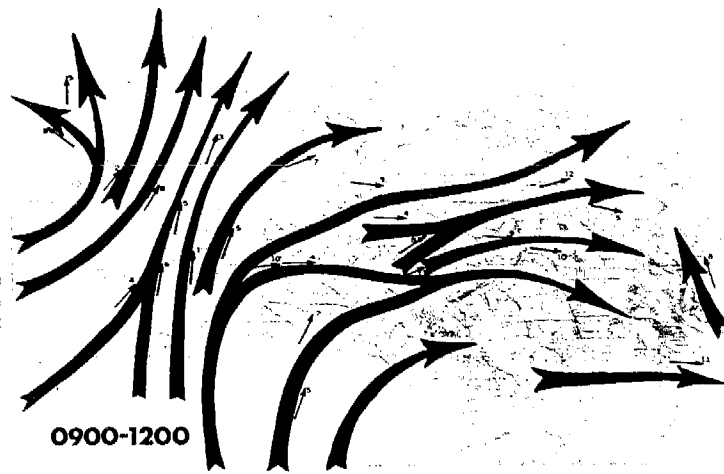
0 5 10 20 30
Map Scale in Miles



Test A	3-4 August 1973	Effective Tracer Concentration	LOS ANGELES SOURCE	 37
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<p>TIMES ARE PACIFIC STANDARD TIME</p> <p>Map Grid - Universal Transverse Mercator Grid - 10,000 Meters</p>	<p>Contours represent an effective average concentration of tracer material from a normalized source of 5×10^{14} particles.</p> <p>..... 1* --- 10 --- 100 --- 1000</p> <p>* Number of particles per cubic meter.</p>	<p></p> <p>Map Scale in Miles</p> <p></p>
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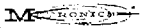


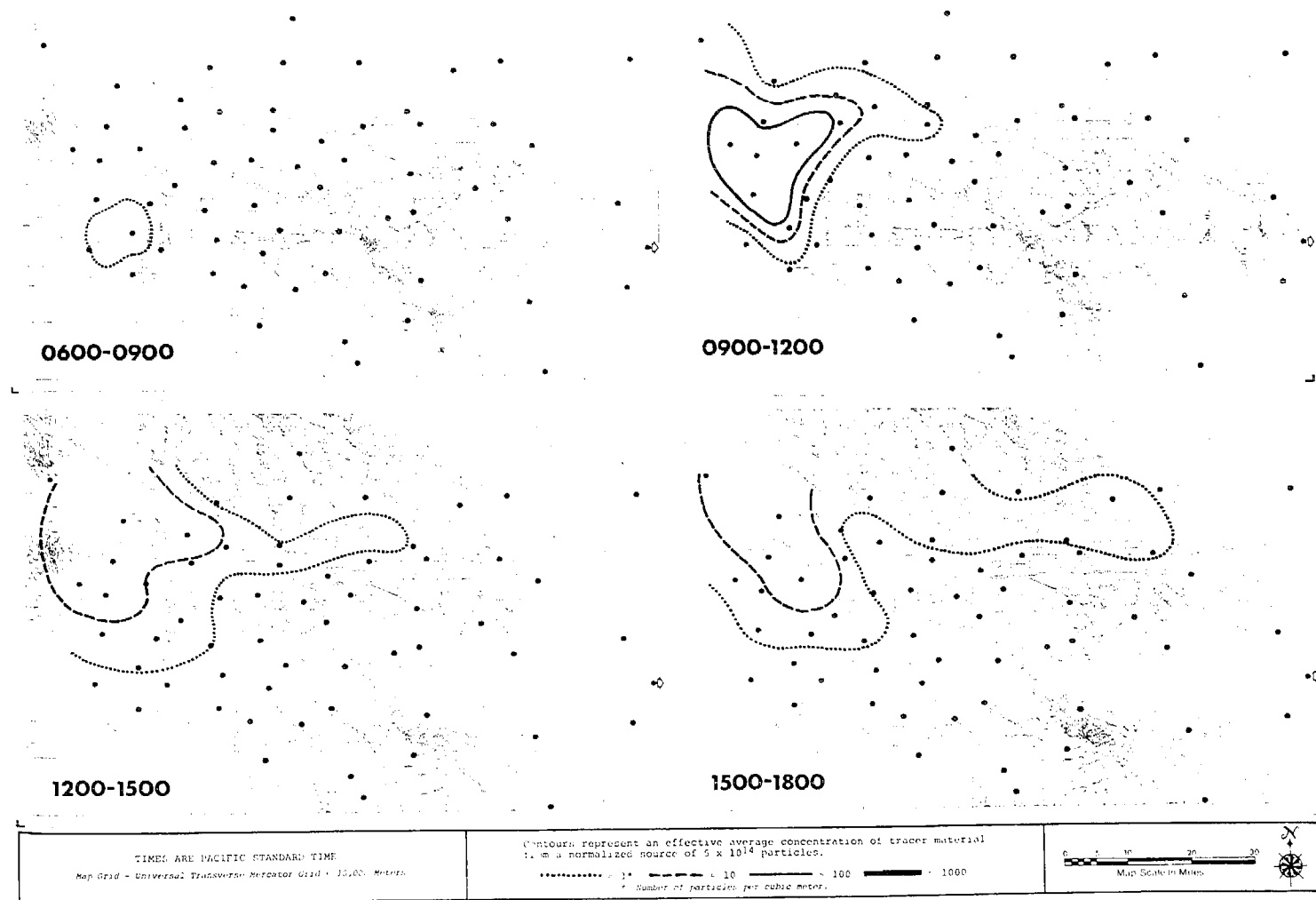
TIMES ARE PACIFIC STANDARD TIME
Map Grid - Universal Transverse Mercator Grid - 10,000 Meters

Wind vectors computed by averaging hourly values for the time periods noted. Both surface and Pibal measurements were used during the daylight hours.

0 5 10 20 30
Map Scale in Miles



Test A	3 August 1973	Effective Tracer Concentration	TORRANCE SOURCE	 39
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40



Test A

3-4 August 1973

Average Wind Streamlines in the Mixing Layer



1800-2400



0600-1200



1200-1800

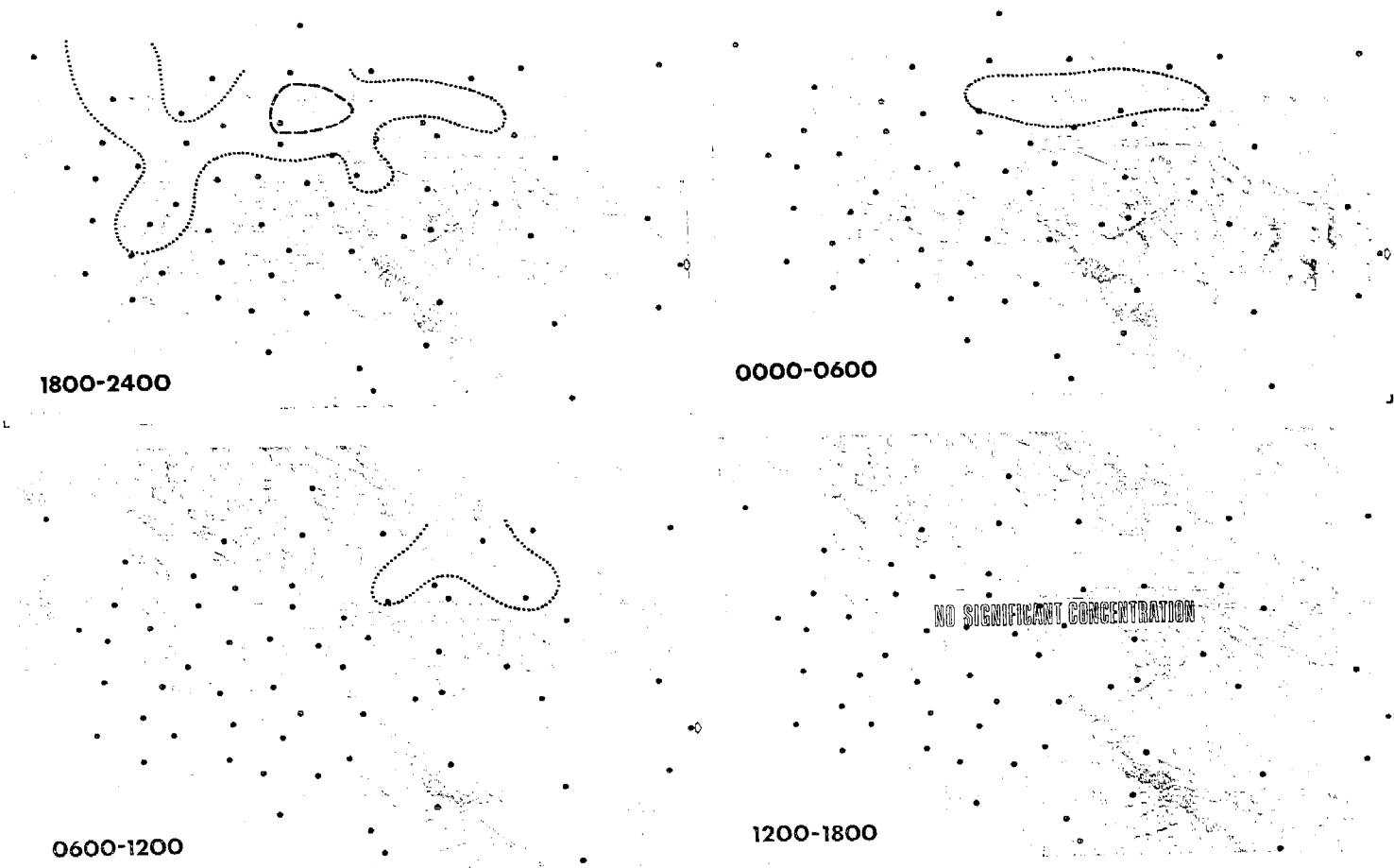
TIMES ARE PACIFIC STANDARD TIME
Map Grid - Universal Transverse Mercator Grid - 10,000 Meters

Wind vectors computed by averaging hourly values for the time periods noted. Both surface and Pibal measurements were used during the daylight hours.

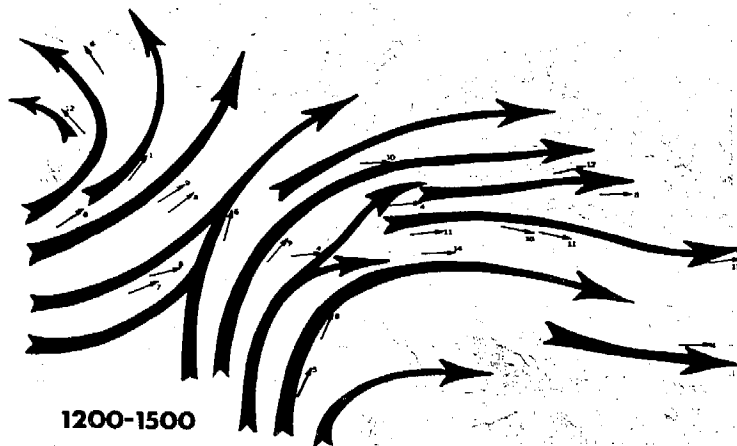
0 5 10 20 30
Map Scale in Miles



Test A	3-4 August 1973	Effective Tracer Concentration	TORRANCE SOURCE	41
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<p>TIMES ARE PACIFIC STANDARD TIME.</p> <p>Map Grid - Universal Transverse Mercator Grid - 5000 Meter</p>	<p>Contours represent an effective average concentration of tracer material from a normalized source of 5×10^{12} particles.</p> <p>..... 1* - - - - 10 ——— 100 ——— 1000</p> <p>* Number of particles per cubic meter.</p>	<p>0 10 20 30</p> <p>Map Scale in Meters</p>
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TIMES ARE PACIFIC STANDARD TIME
Map Grid - Universal Transverse Mercator Grid - 10,000 Meters

Wind vectors computed by averaging hourly values for the time periods noted. Both surface and Pibal measurements were used during the daylight hours.

0 5 10 20 30
Map Scale in Miles



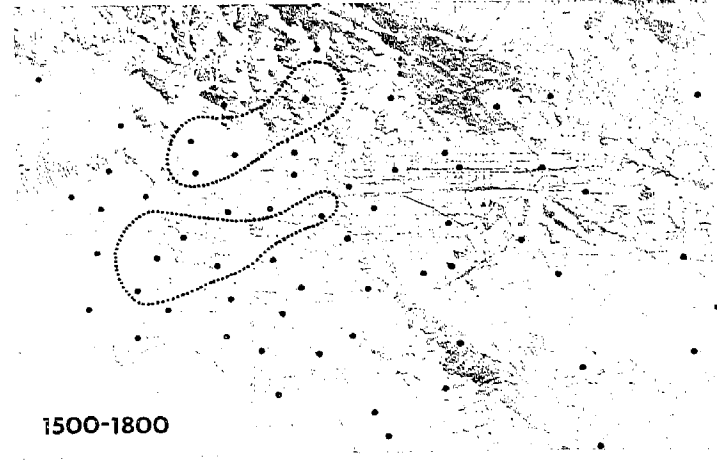
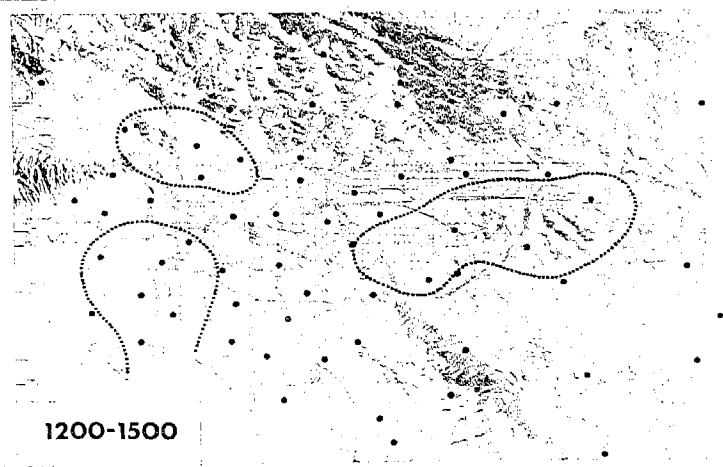
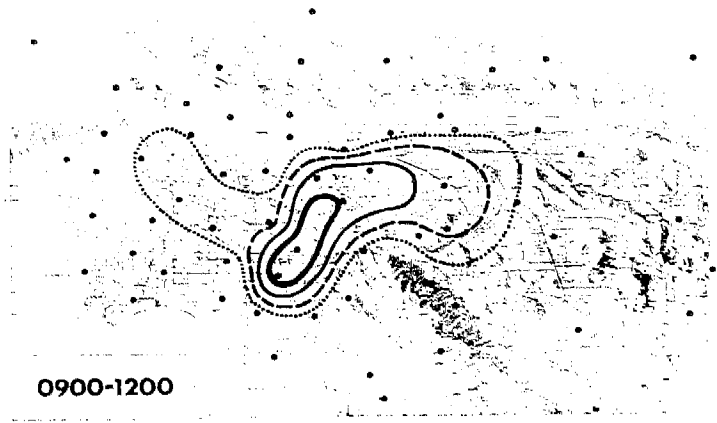
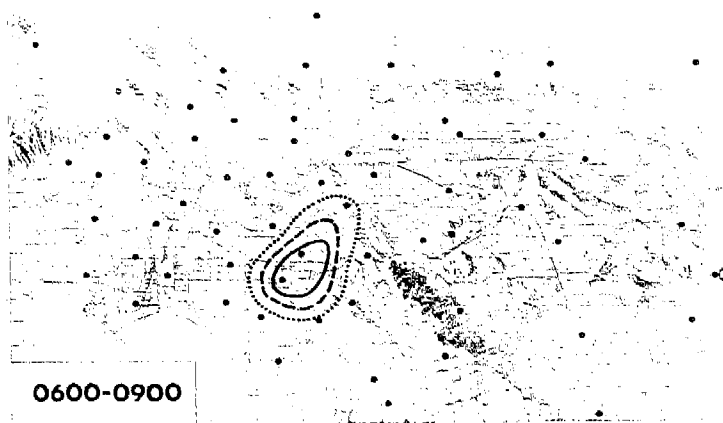
Test A

3 August 1973

Effective Tracer Concentration

SANTA ANA SOURCE

43



TIME: ARE LOCAL STANDARD TIME

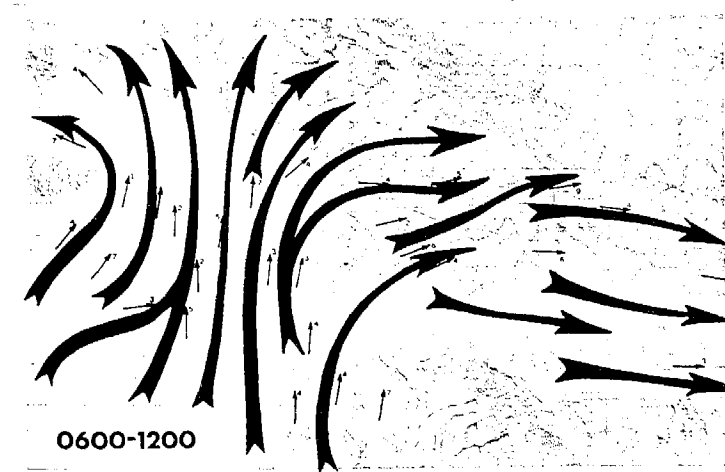
Map Data - Universal Transverse Mercator 1250 1250 1250

Contours represent an effective average concentration of tracer material from a normalized source of 5×10^{15} particles.

1 10 100 1000
Number of particles per cubic meter.

Map Scale in Miles





Test A	3-4 August 1973	Effective Tracer Concentration	SANTA ANA SOURCE	45
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1800-2400

0000-0600

NO SIGNIFICANT CONCENTRATION

NO SIGNIFICANT CONCENTRATION

0600-1200

1200-1800

TIMEZ ARE PACIFIC STANDARD TIME

Map Grid - Universal Transverse Mercator Grid - 10,000 Meters

Contours represent an effective average concentration of tracer material from a normalized source of 5×10^{14} particles.

..... 1* 10 100 1000
* Number of particles per cubic meter

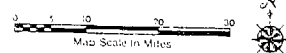
0 5 10 20 30
Map Scale in Miles



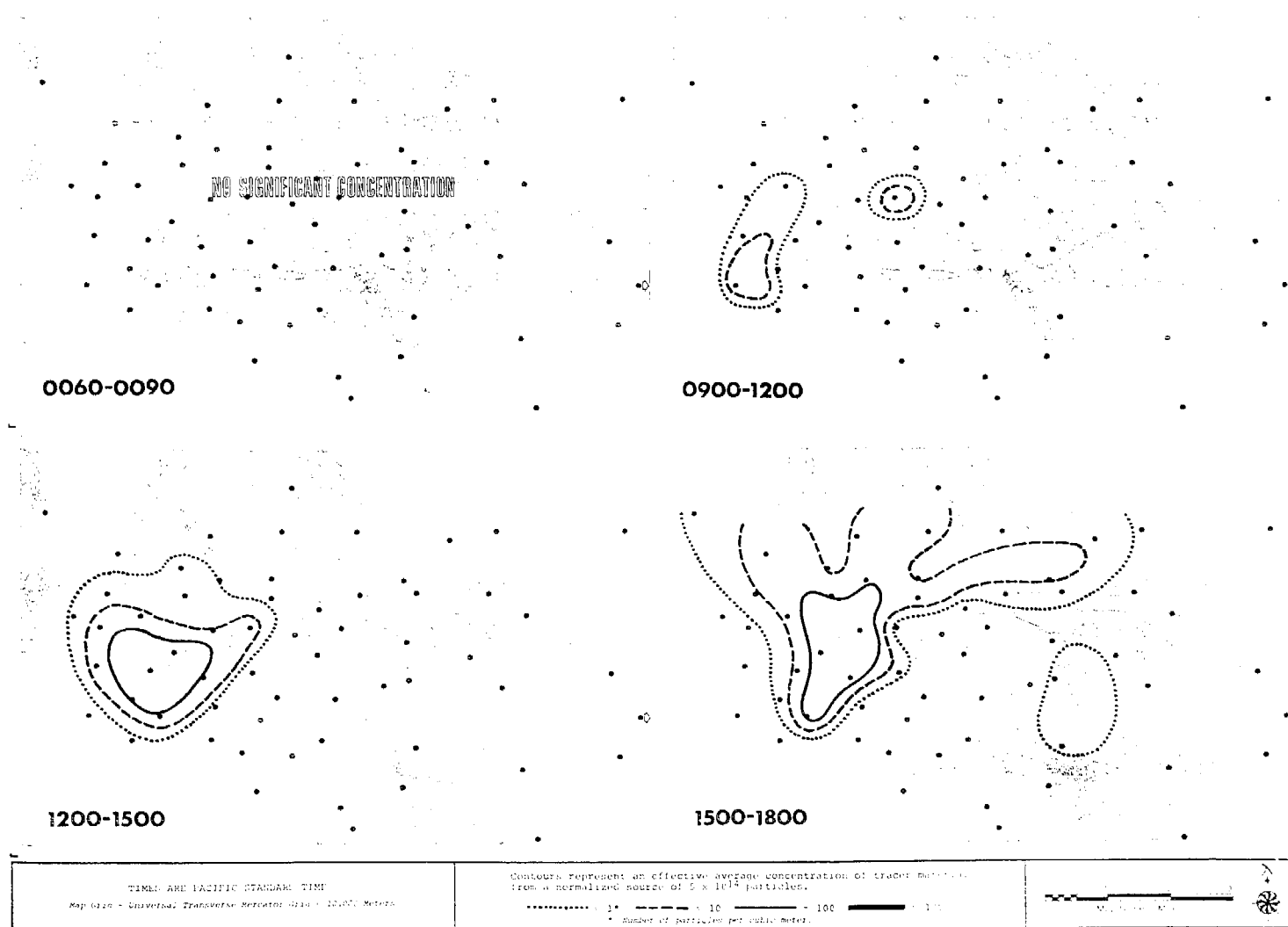


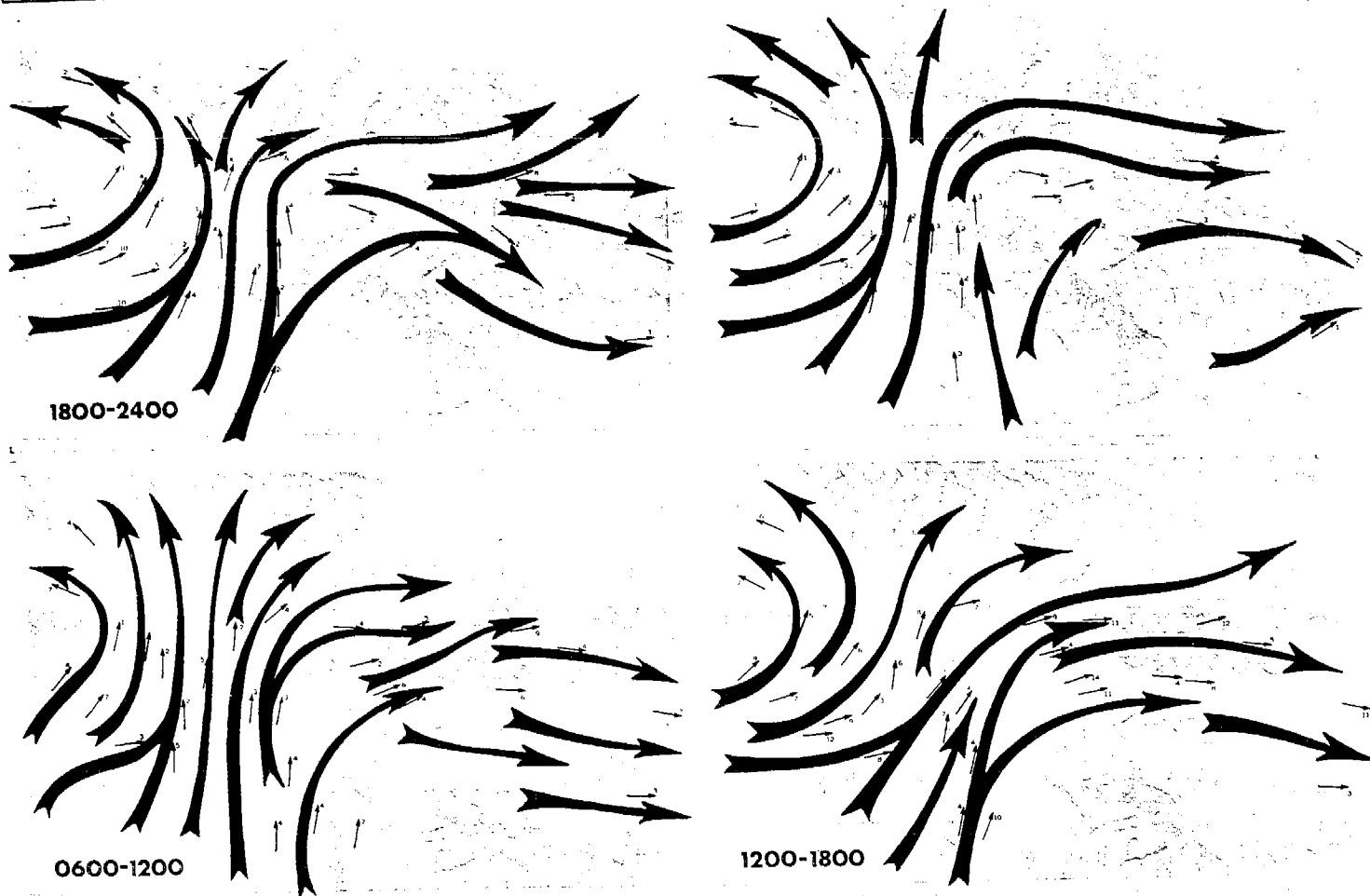
Map Grid - Universal Transverse Mercator Zone 18, 60N, Metric.

Wind vectors computed by averaging hourly values for the time periods noted. Both surface and Pibal measurements were used during the daylight hours.



Test A	3 August 1973	Effective Tracer Concentration	LONG BEACH SOURCE ELEVATED	MAP 47
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TIMES ARE PACIFIC STANDARD TIME

Map Grid - Universal Transverse Mercator Grid - 10,000 Meters

Wind vectors computed by averaging hourly values for the time periods noted. Both surface and Pibal measurements were used during the daylight hours.

0 5 10 20 30
Map Scale in Miles

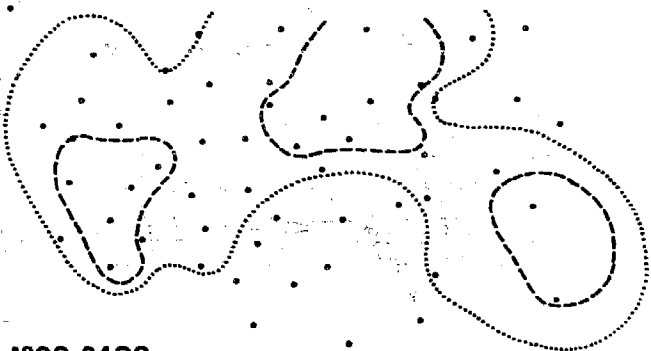
Test A

3-4 August 1973

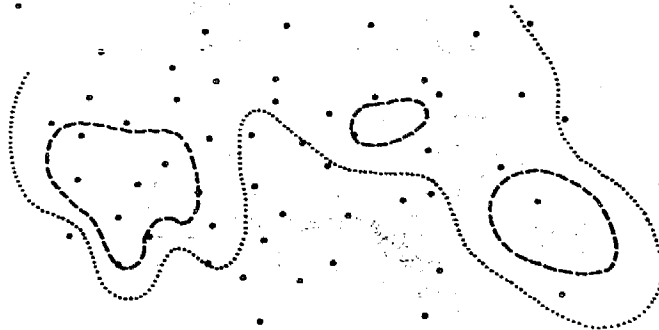
Effective Tracer Concentration

LONG BEACH SOURCE
ELEVATED

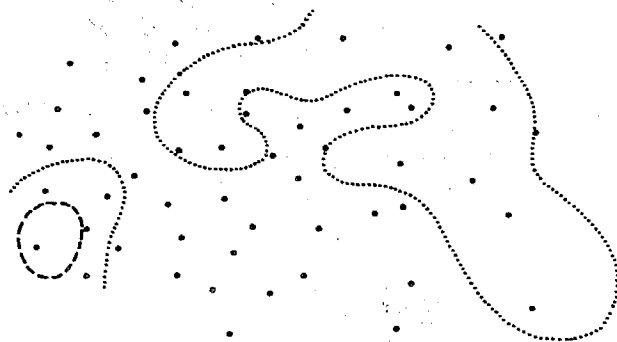
49



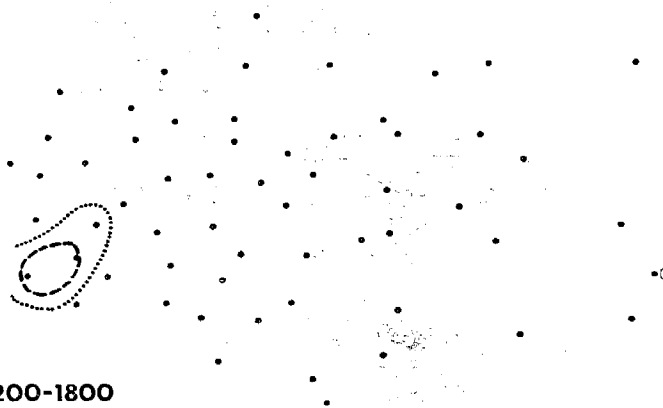
1800-2400



0000-0600



0600-1200



1200-1800

TIMES ARE PACIFIC STANDARD TIME

Map Grid - Universal Transverse Mercator Grid - 10,000 Meters

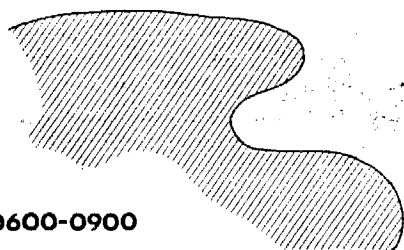
Contours represent an effective average concentration of tracer material from a normalized source of 5×10^{14} particles.

..... 1 - - - - - 10 ———— 100 ———— 1000
* number of particles per cubic meter.

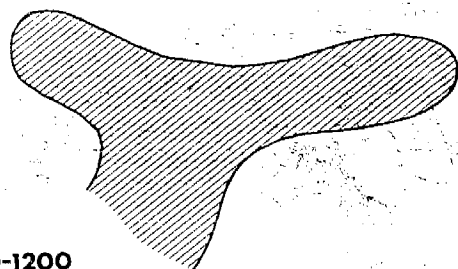
0 5 10 20 30
Map Scale in Miles



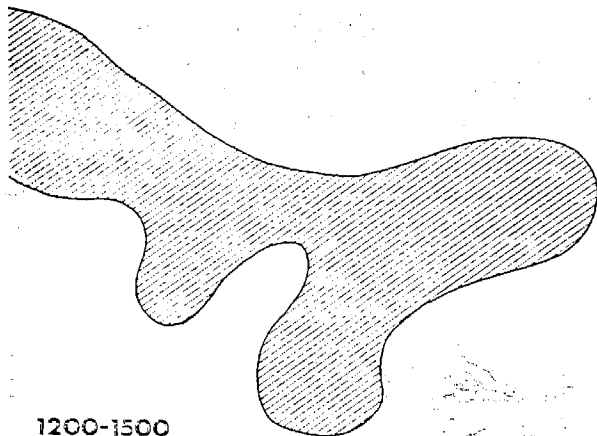
0600-0900



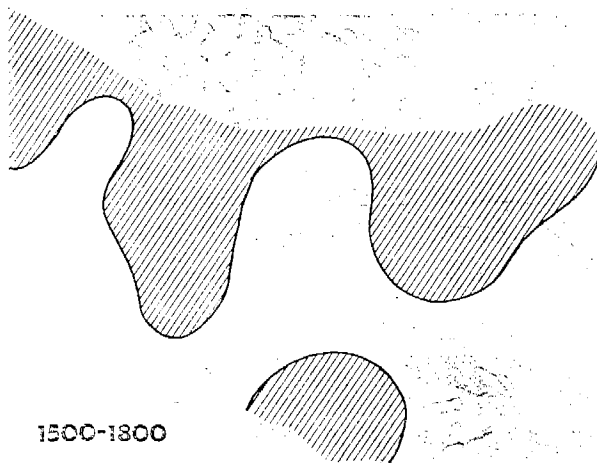
0900-1200



1200-1500



1500-1800



TIMES ARE PACIFIC STANDARD TIME
Map Grid - Universal Transverse Mercator Grid - 11,000 Meters



Shading indicates where deviation index is greater than unity.

0 5 10 20 30
Map Scale in Miles



Test B, 13-14 September 1973

METEOROLOGY

SYNOPTIC WEATHER

On the morning of 13 September 1973 the Pacific high was south of its normal position and a weak cold front was about 150 miles from the northern California coast (Page 53). There was extensive cloudiness along the coast with light drizzle and fog as far south as San Diego. There was a high pressure area over British Columbia and a high pressure ridge at the 500 mb level off the coast preventing any extensive precipitation from the frontal zone.

The front had moved inland by the morning of 14 September with a low pressure center developing over northern Utah. The high pressure ridge off the coast persisted but the low pressure trough over western Canada deepened and extended southwestward over northern California strengthening the onshore gradient and providing continued cloudiness.

LOCAL WEATHER

Skies were overcast throughout the entire area with extensive fog and haze. Visibilities ranged from 5/8 to 5 miles. Winds were predominantly easterly to southeasterly except in the north coastal area near Santa Monica. The winds became south to southwesterly throughout the Los Angeles Basin by noon and westerly in the eastern Basin. This pattern persisted through the afternoon.

By midday skies were still overcast except in the San Bernardino-Riverside area with visibilities less than six miles in fog, haze or smoke. The inland area was generally clear of clouds by midafternoon but visibilities were still six miles or less.

Morning soundings at Los Angeles International Airport and El Monte showed strong (9° C) inversion at about 900 m (3000 ft.) with very moist air below the inversion and very dry air above. The inversion persisted

through the day but lowered to about 750 m (2500 ft.) by midday. Mixing heights were 450-750 m (1500-2500 ft.) during the day (Page 54).

On the second day the area was again overcast, with fog in most inland areas and light drizzle along the south coast area near El Toro. The morning winds produced a convergence zone along a line from Burbank to Buena Park. To the east of the line winds were east to northeast. To the west, the winds were southwest. By midday the winds were generally southwesterly in the Los Angeles Basin except near the San Fernando Valley where they were southeasterly and this pattern persisted through the day, becoming slightly more westerly in the afternoon. The inversion at Los Angeles Airport and El Monte was again about 9° C with base at 750 m (2500 ft.) in the morning lowering to 700 m (2300 ft.) by midday. Mixing heights ranged generally from 450 m to 750 m (1500-2500 ft.) during the day (Page 55).

Pollution potential was classified as Moderate.

DESCRIPTION OF TRACER RESULTS

Emission of tracer from all sources (Los Angeles, Torrance, Santa Ana, Long Beach) began at 0600 PST and continued to 1100 PST. This release period was longer than in the previous test in order to minimize the effect of the extremely variable winds prevalent in the early morning as discussed in the section on meteorological classification.

LOS ANGELES SOURCE AREA

Tracer from the downtown Los Angeles area moved primarily northward into the San Fernando Valley. A smaller portion of the cloud was caught in an early morning offshore flow and went out over the ocean. When the wind shifted, tracer was carried back onshore to the south of the release area. As the day progressed this dilute portion of the cloud was moved east-northeast along the base of the San Gabriel Mountains as far as Riverside and San Bernardino where it remained during the night and dissipated the following day.

TORRANCE SOURCE AREA

Tracer from the Torrance area moved predominantly east over the Chino and Puente Hills diluting rapidly. It reached the San Bernardino-Riverside area by late evening and dissipated during the night. A very small portion of the cloud moved north over downtown Los Angeles. A small residual cloud showed up near the release area the next day.

SANTA ANA SOURCE AREA

Tracer from the Santa Ana-Anaheim area began moving to the north-northwest but shifted direction to the east by midday. The major portion of the tracer moved through the Santa Ana Canyon toward Riverside. A significant amount of tracer was carried aloft to the mountains northeast of San Bernardino. The tracer dissipated during the night.

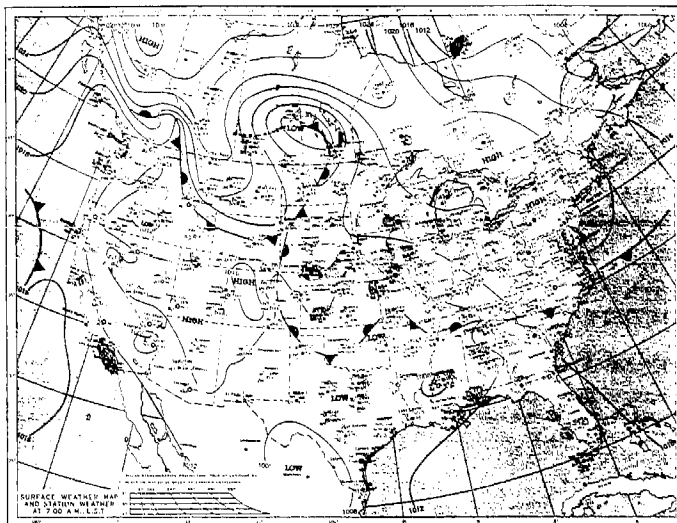
LONG BEACH (elevated) SOURCE

Tracer from the power plant stack near Long Beach began moving north but shifted to east-southeast by midday and east by late afternoon. By evening the cloud was substantially diluted and extended from Long Beach to the Riverside area. During the night this large cloud was split along the Santa Ana Mountains. It dissipated by the next morning.

NORMALIZED OXIDANT

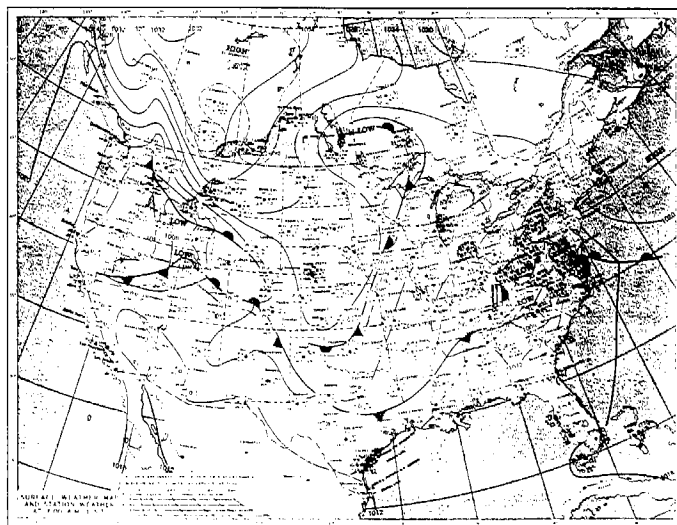
The Normalized Oxidant maps for the first twelve hours of the test day indicate a pattern consistent with transport of polluted air from west to east. In this test, the extension of relatively clean marine air was not as widespread as in Test A, but its effect on the overall pattern can still be seen. By late afternoon the central Los Angeles Basin and parts of the San Fernando Valley again showed a deviation index greater than unity along with the eastern Basin.

THURSDAY, SEPTEMBER 13, 1973



Surface Weather for Air Tracer Test B at
4:00 A.M. PST on 13 and 14 September 1973

FRIDAY, SEPTEMBER 14, 1973

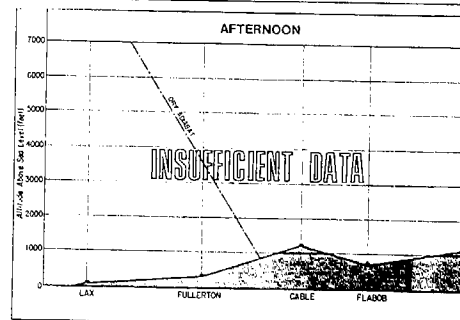
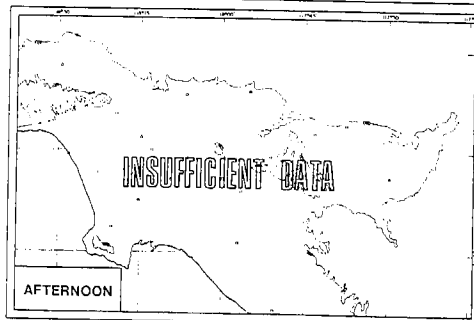
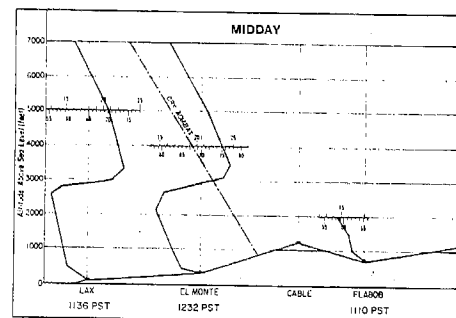
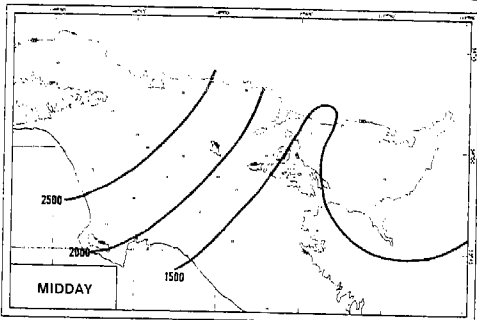
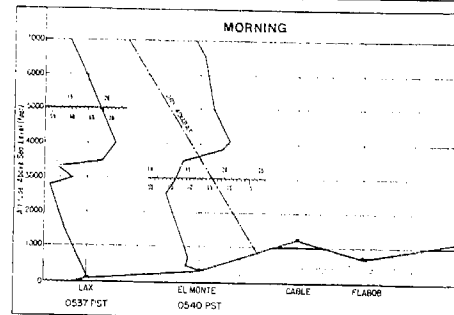
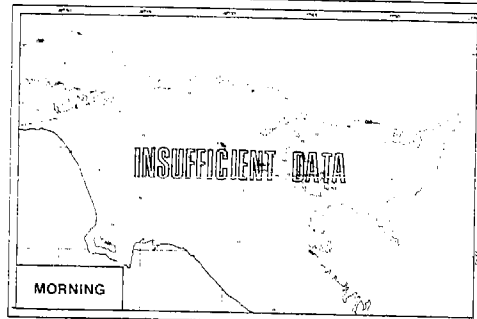


Test B

13 September 1973

MIXING HEIGHTS

VERTICAL TEMPERATURES



0 5 10 20 25
Scale in Miles

Contours represent estimated height of
the inversion base in feet above surface.

TEMPERATURE 10 15 °CENTIGRADE
50 55 60 65 °FAHRENHEIT

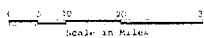
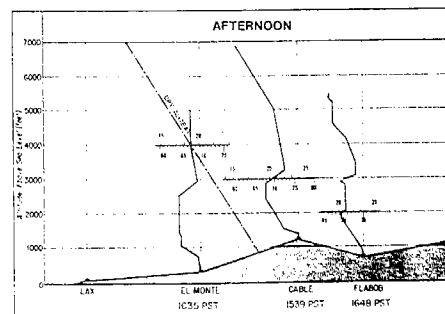
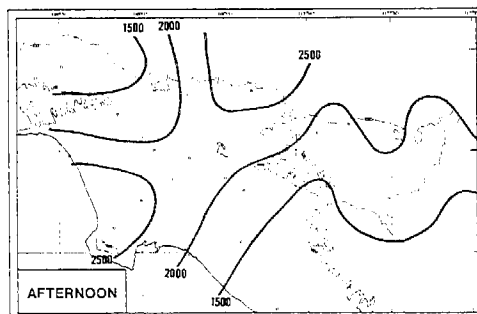
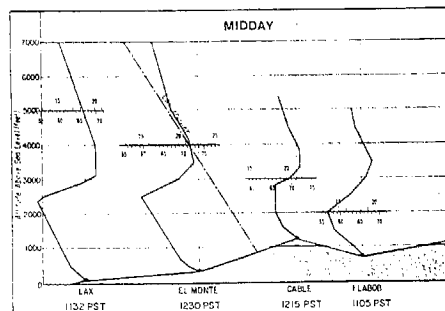
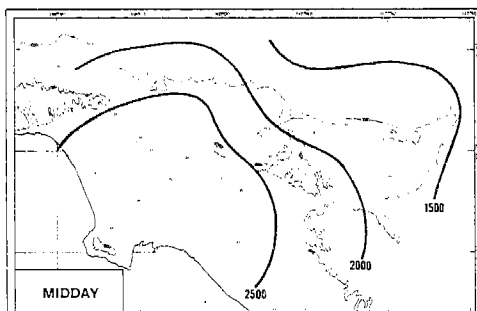
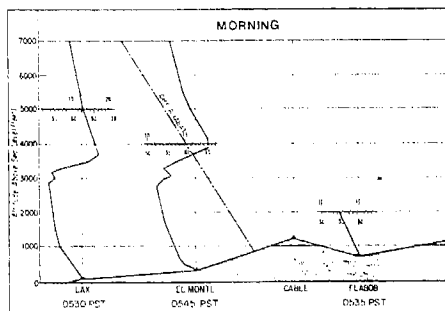
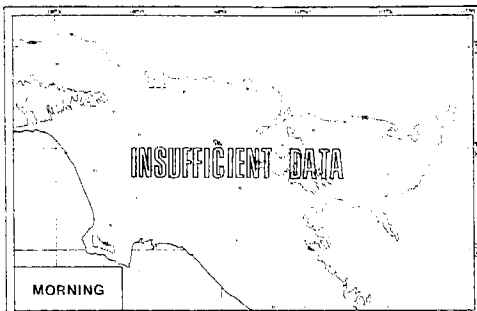
Test B

14 September 1973

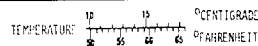
55

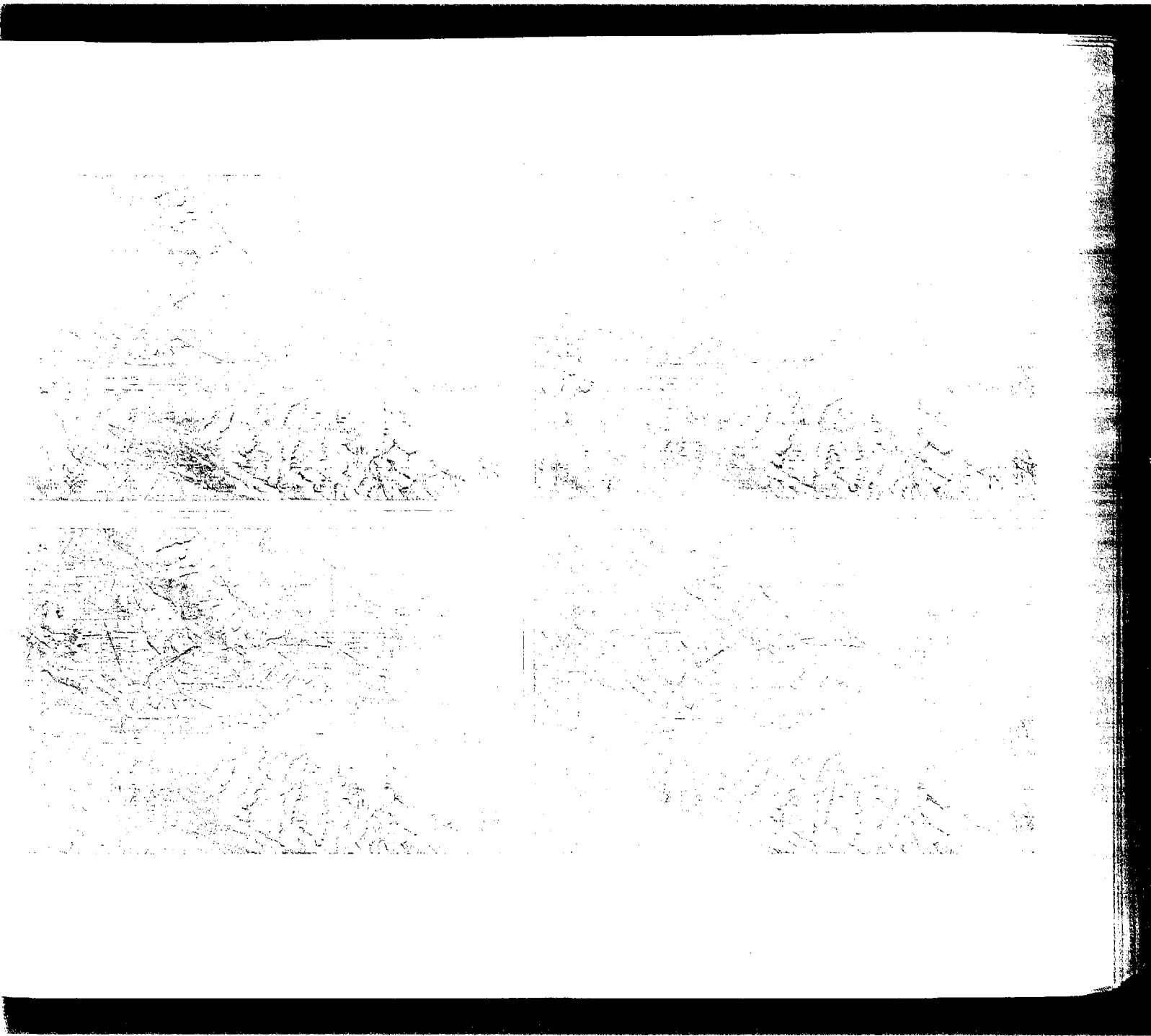
MIXING HEIGHTS

VERTICAL TEMPERATURES



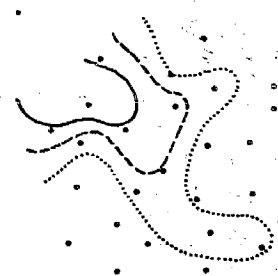
Contours represent estimated height of the inversion base in feet above surface.



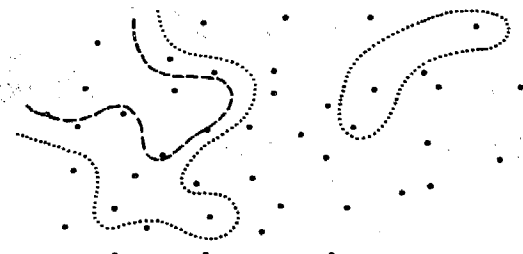




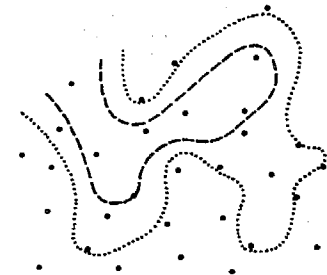
0600-0900



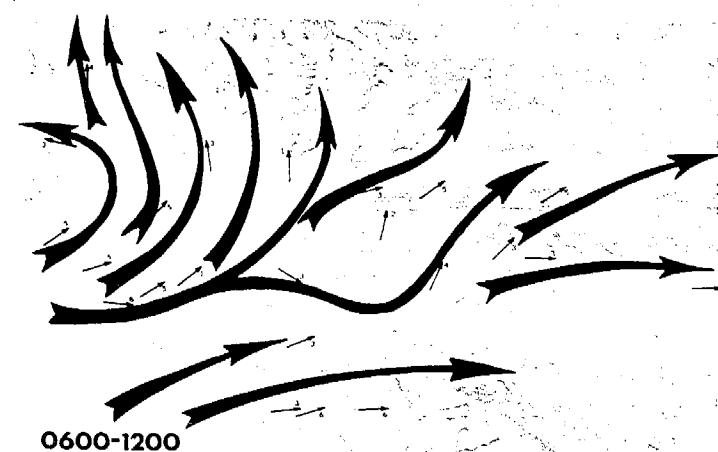
0900-1200



1200-1500



1500-1800

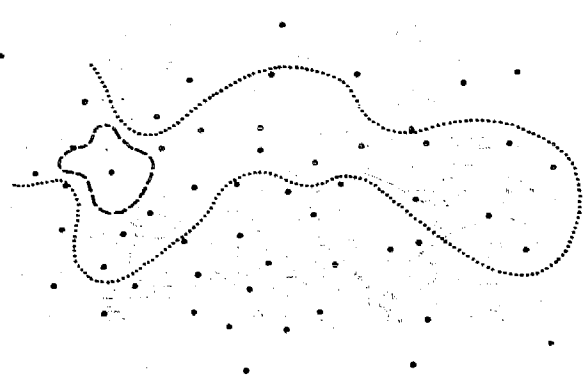


TIMES ARE PACIFIC STANDARD TIME
Map Grid - Universal Transverse Mercator Grid - 10,000 Meters

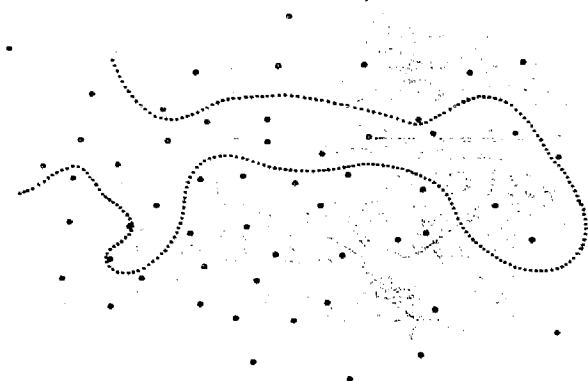
Wind vectors computed by averaging hourly values for the time periods noted. Both surface and Pibal measurements were used during the daylight hours.

0 5 10 20 30
Map Scale in Miles

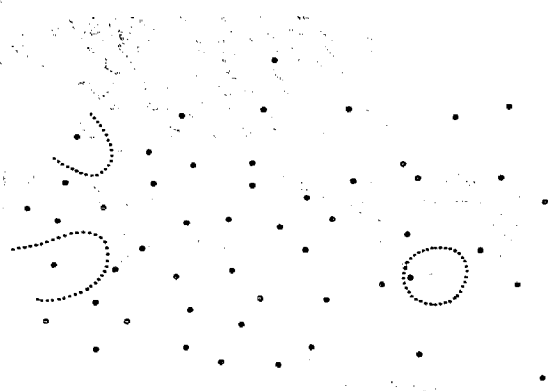




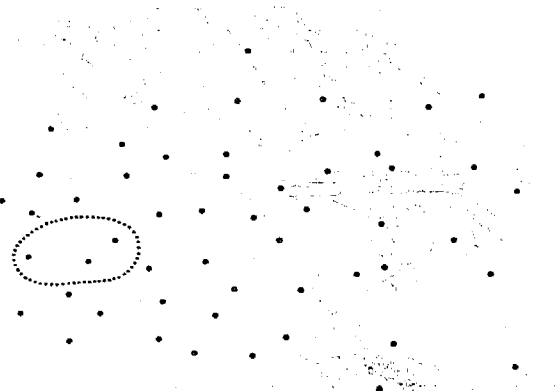
1800-2400



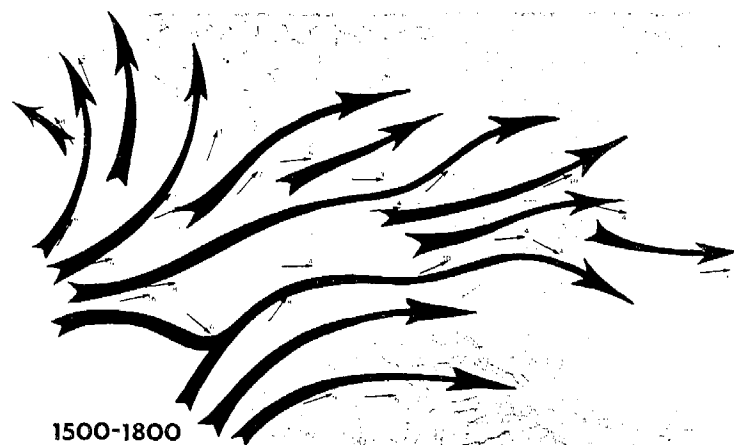
0000-0600



0600-1200



1200-1800



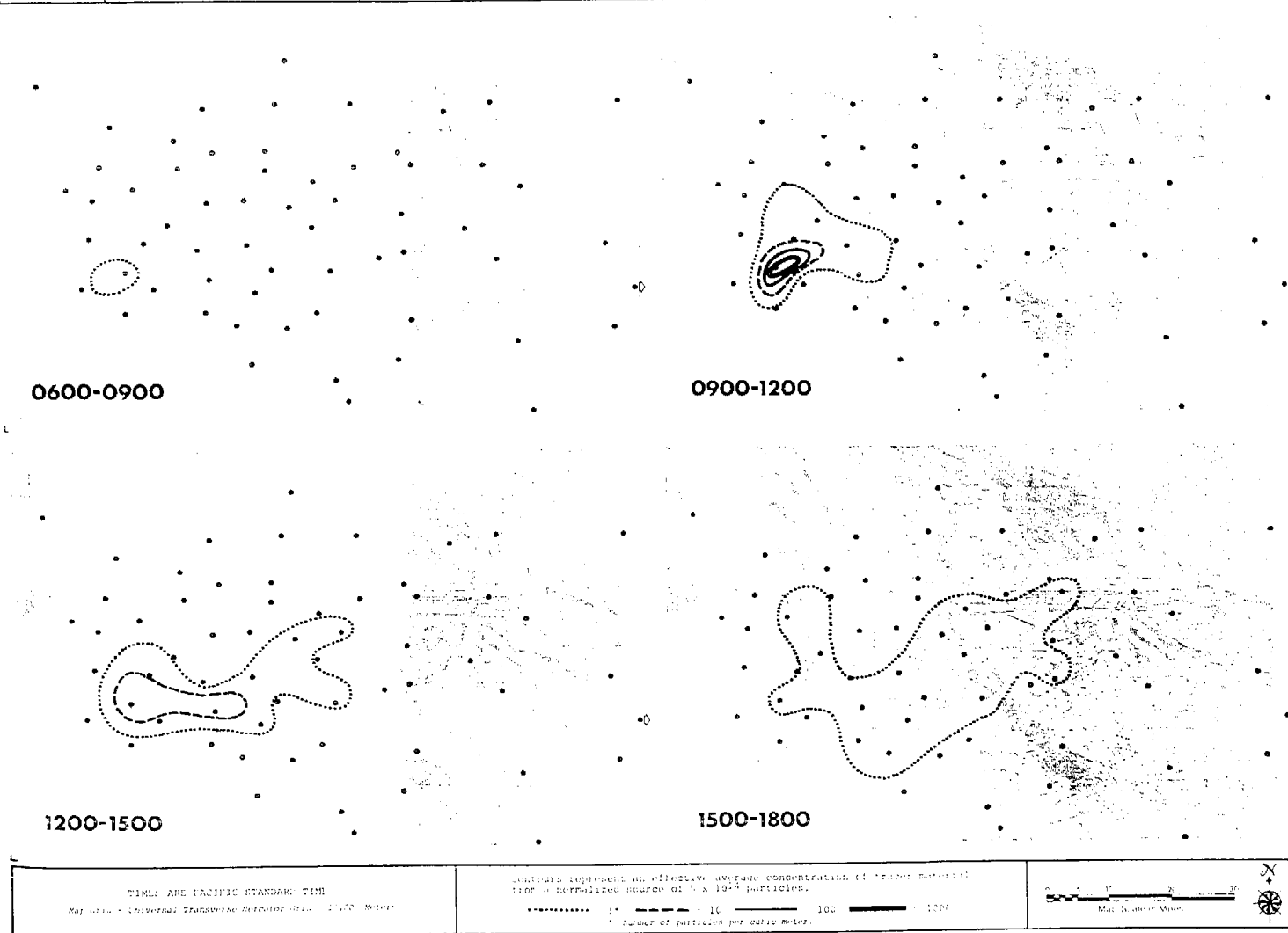
TIME: ARE LOCAL STANDARD TIME
Map Grid - Horizontal Transverse Magnetic (HTM) 1:100,000

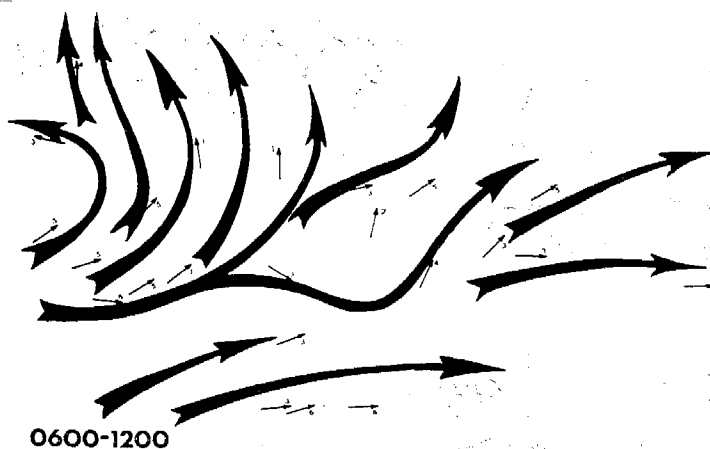
Wind vectors computed by averaging hourly values for the time periods noted. Both surface and Pilot measurements were used during the daylight hours.

0 10 20 30
Map Scale in Miles



Test B	13 September 1973	Effective Tracer Concentration	TORRANCE SOURCE	61
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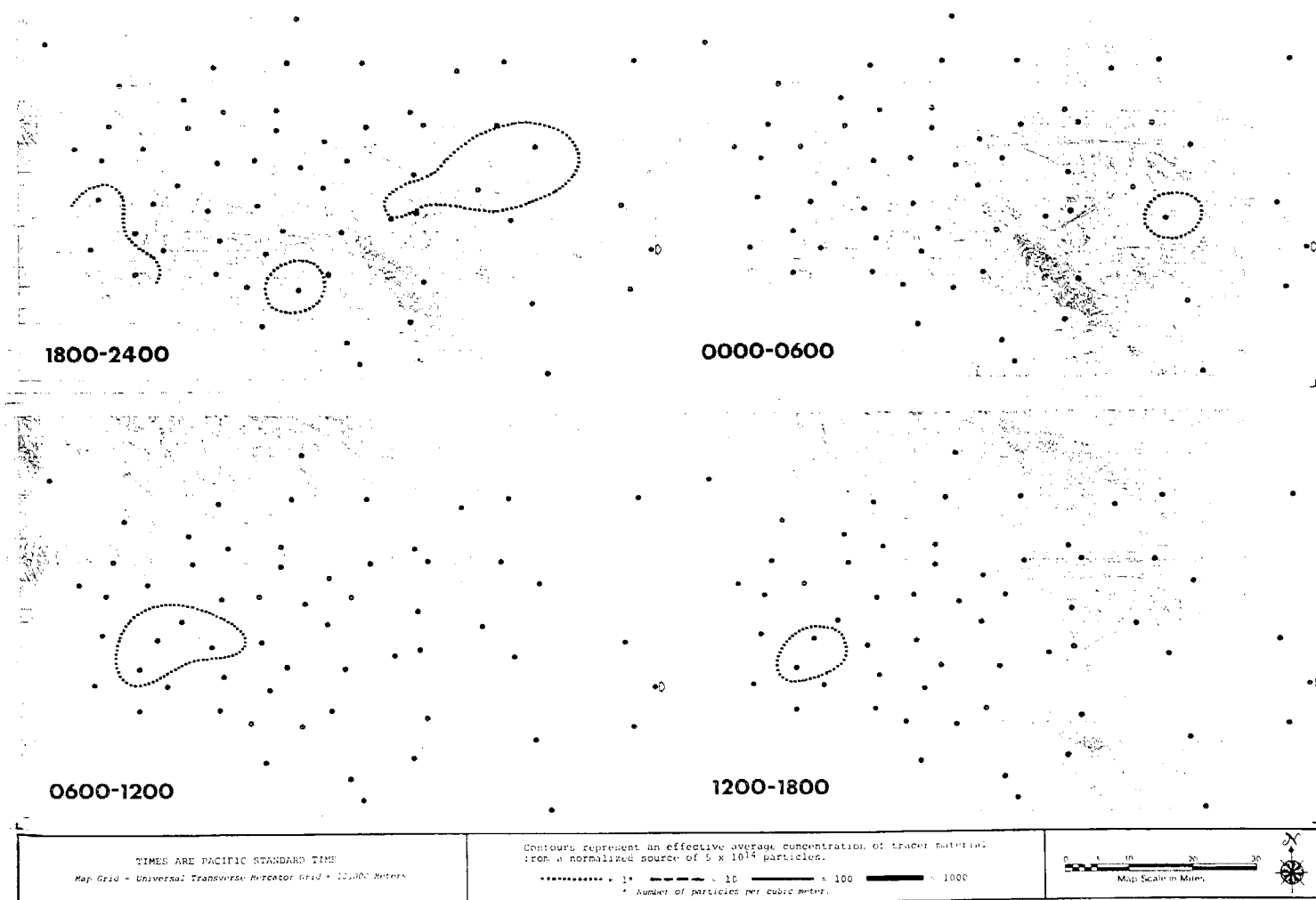
TIMES ARE PACIFIC STANDARD TIME
Map Grid - Universal Transverse Mercator Grid - 10,000 Meters

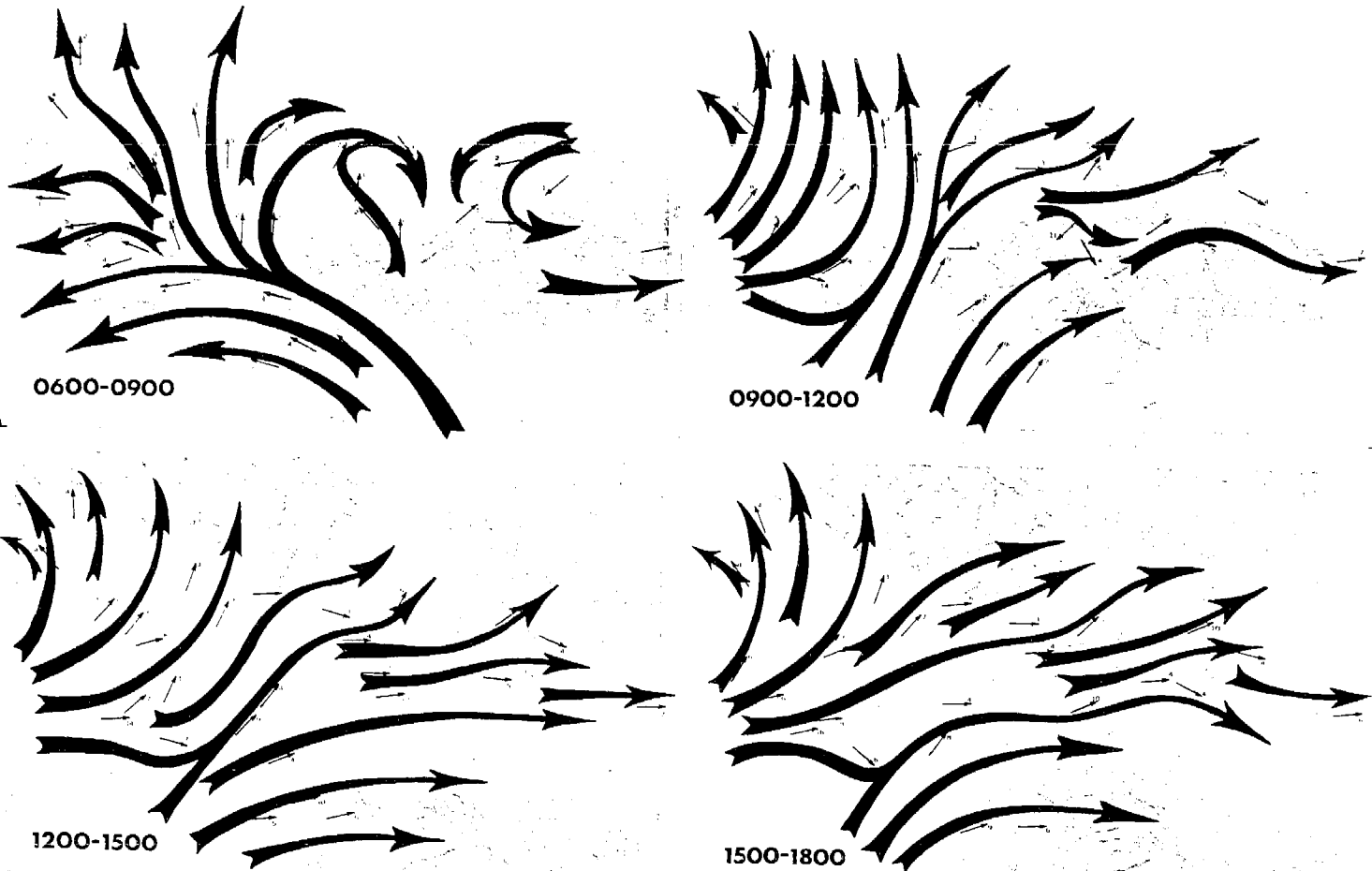
Wind vectors computed by averaging hourly values for the time periods noted. Both surface and Pibal measurements were used during the daylight hours.

0 5 10 20 30
Map Scale in Miles



Test B	13-14 September 1973	Effective Tracer Concentration	TORRANCE SOURCE	 63
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TIMES ARE PACIFIC STANDARD TIME

Map scale - 1:1,000,000. Transverse direction scale - 1:1,000,000.

Wind vectors computed by averaging hourly values for the time periods noted. Both surface and Pibal measurements were used during the daylight hours.

0 10 20 30
Map Scale in Miles

Test B

13 September 1973

Effective Tracer Concentration

SANTA ANA SOURCE

65

0600-0900

0900-1200

1200-1500

1500-1800

TIMES ARE PACIFIC STANDARD TIME.

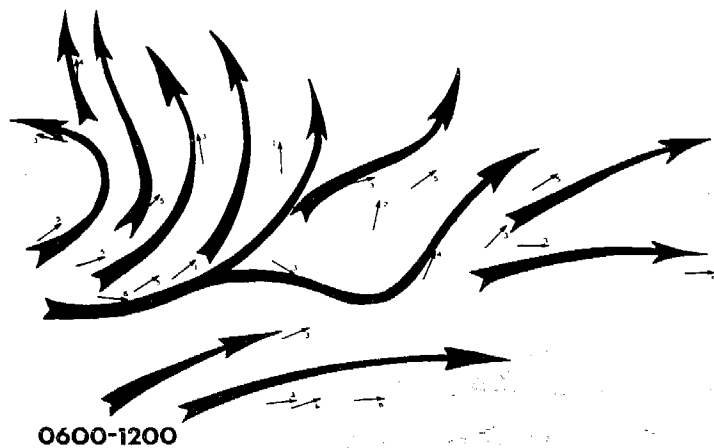
Map Grid - Universal Transverse Mercator Grid - 17,000 Meters

Contours represent an effective average concentration of tracer material from a normalized source of 5×10^{15} particles.

..... 1 * --- 10 = 100 = 1000
* Number of particles per cubic meter.

0 10 20 30
Miles Scale in Map





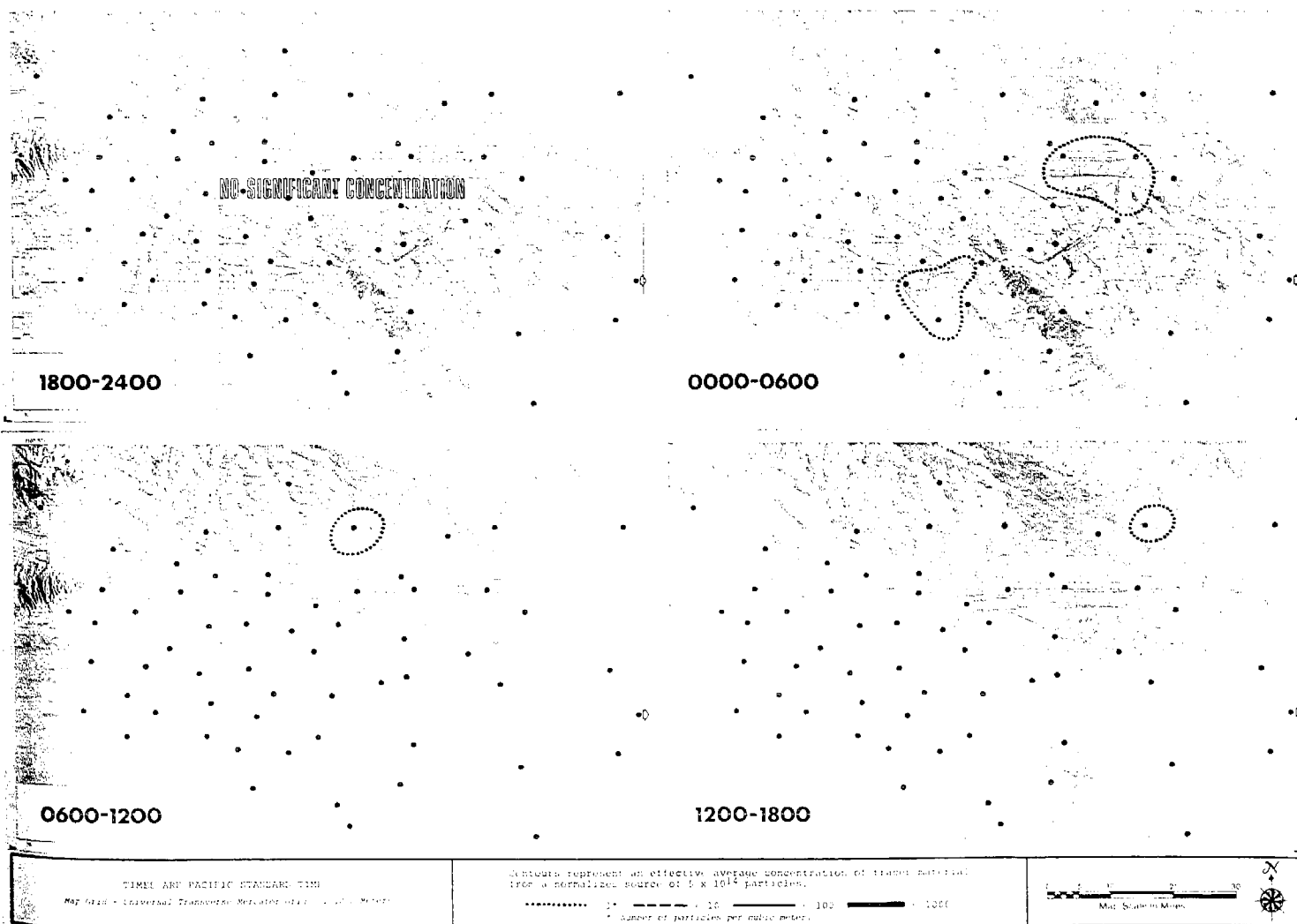
TIMES ARE PACIFIC STANDARD TIME
Map Grid - Universal Transverse Mercator Grid - 10,000 Meters

Wind vectors computed by averaging hourly values for the time periods noted. Both surface and Pibal measurements were used during the daylight hours.

0 5 10 20 30
Map Scale in Miles



Test B	13-14 September 1973	Effective Tracer Concentration	SANTA ANA SOURCE	67
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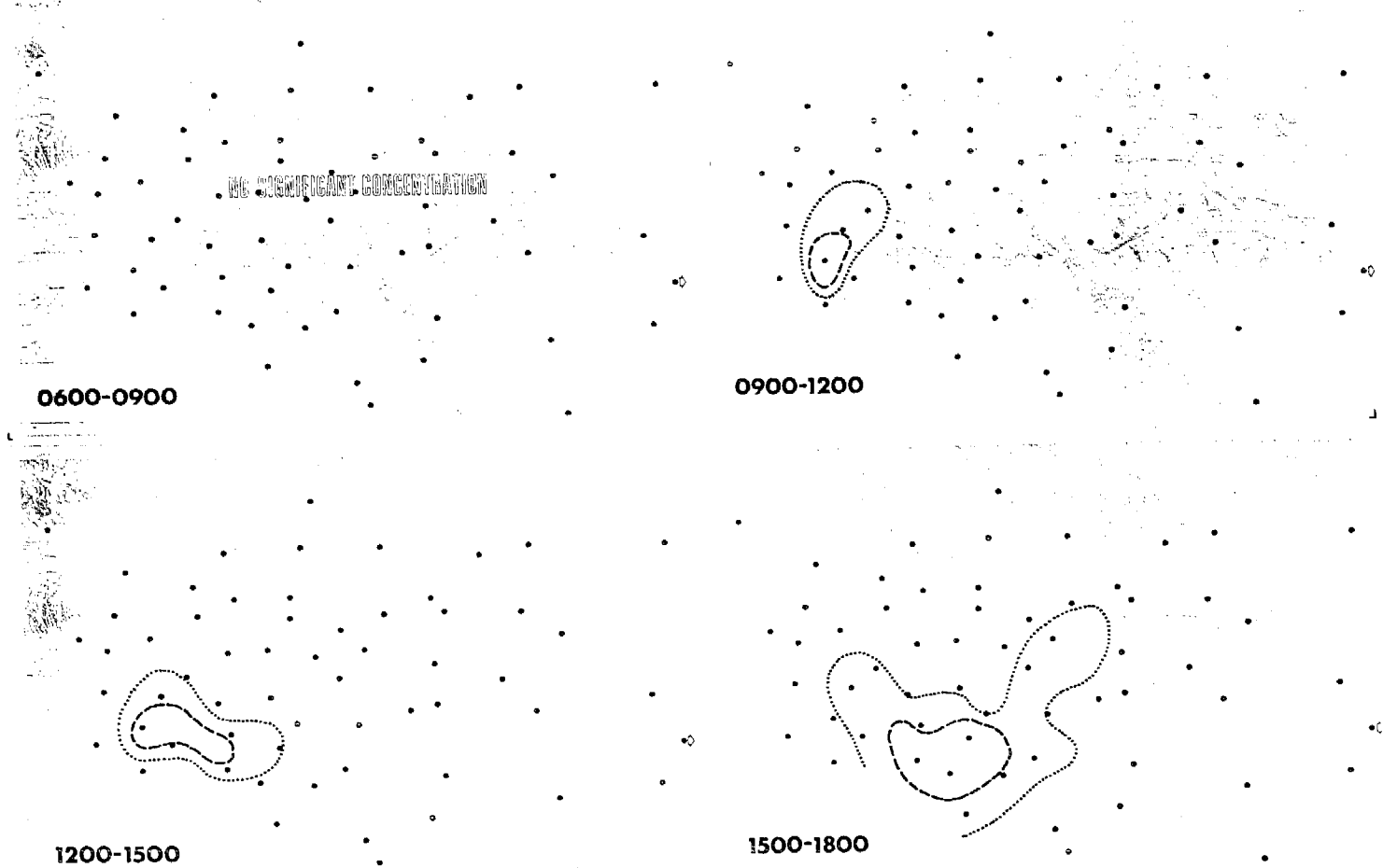
TIMEZ ARE LOCAL STANDARD TIME

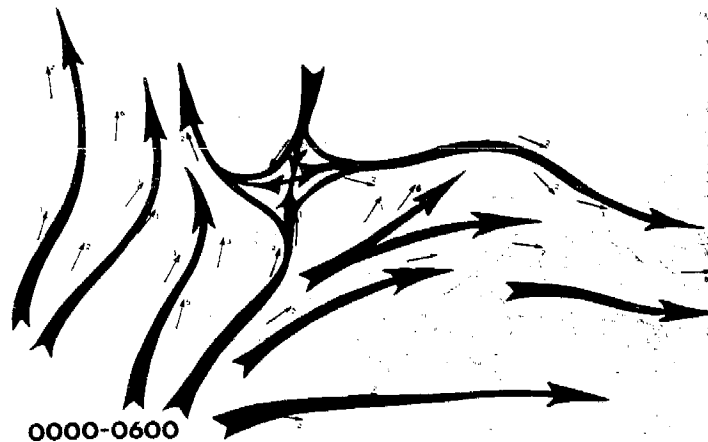
Map Scale: 1 inch = 10 miles

Wind vectors computed by averaging hourly values for the time periods noted. Both surface and pilot measurements were used during the daylight hours.

Map Scale in Miles







TIMES ARE PACIFIC STANDARD TIME
Map Grid - Universal Transverse Mercator Grid - 10,000 Meters

Wind vectors computed by averaging hourly values for the time periods noted. Both surface and Pibal measurements were used during the daylight hours.

0 5 10 20 30
Map Scale in Miles

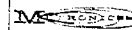


Test B

13-14 September 1973

Effective Tracer Concentration

LONG BEACH SOURCE
ELEVATED



71

1800-2400

0000-0600

0600-1200

1200-1800

TIME: ARE PACIFIC STANDARD TIME

Map Grid - Universal Transverse Mercator UTM - 11QD - 500000

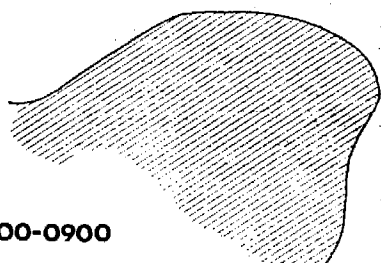
Contours represent an effective average concentration of tracer material from a normalized source of 5×10^{14} particles.

..... 1* 10 100 1000
Number of particles per cubic meter.

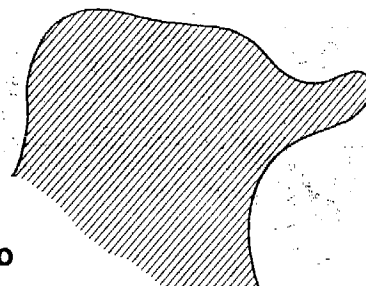
0 5 10 20 30
Miles
0 5 10 20 30
Miles



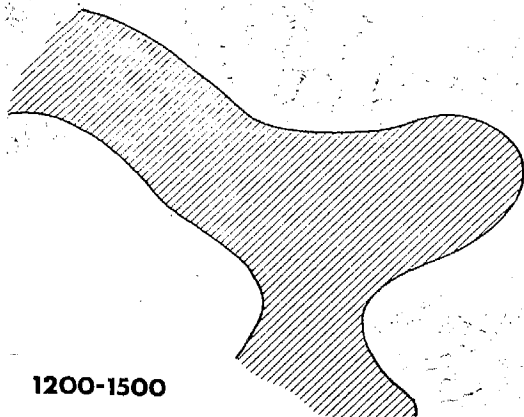
0600-0900



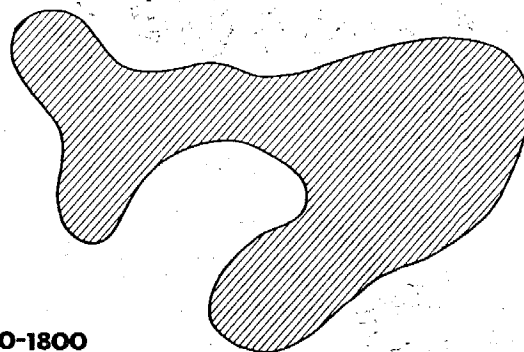
0900-1200



1200-1500



1500-1800



TIMES ARE PACIFIC STANDARD TIME
Map Grid - Universal Transverse Mercator Grid - 10,000 Meters



Shading indicates where deviation index is greater than unity.

0 5 10 20 30
Map Scale in Miles



Test C, 29-30 September 1973

METEOROLOGY

SYNOPTIC WEATHER

On the morning of 29 September a ridge of high pressure extended northeastward from the Pacific high into British Columbia (Page 75). A weak cold front extended southwestward from a low near the border of Saskatchewan and Manitoba across Washington and Oregon but had no effect on the South Coast Basin at this time. A thermal trough had developed near Yuma, Arizona after the weak Santa Ana winds during the preceding day had died out. The presence of the thermal trough indicated the normal sea breeze would develop during the day.

A composite satellite photograph of the western portion of Canada and the United States extending westward to about 160 degrees west longitude is shown on Page 77. The photos were taken between 0900 and 1400 PST on 29 September. One spiral cloud pattern in the upper right section corresponds to the low center on the surface weather map and a band of clouds offshore show this weak cold front approaching the coast. A broad area of stratus clouds in the center of the picture lies just off the southern California coast, but skies were clear over the entire South Coast Air Basin.

By the morning of 30 September, the cold front had moved into Northern California and a low pressure area had developed over the Sacramento-San Joaquin Valley. The thermal trough in the interior extended northward to Tonopah, Nevada with a resulting intensification of the onshore pressure gradient.

LOCAL WEATHER

Santa Ana winds had cleared the area of "smog" earlier in the week and the offshore flow, although weak, persisted through Friday, 28 September. On the morning of the 29th, however, a sea breeze developed and penetrated well inland reaching full development by 1400 PST. Skies were

generally clear after the early morning hours. Visibilities had increased over most of the western Basin. By 1600 PST visibilities had increased to seven miles or greater over most of the region except the north coastal area, the San Gabriel Valley and the San Bernardino area.

Winds in the mixing layer were generally south to southwest in the coastal area and east to southeast over most of the remaining area from 0600-0900 PST. The winds shifted more southwesterly over the western Basin and west to southwest in the eastern Basin during the late morning, 0900-1200 PST. This westerly pattern persisted for the remainder of the day.

Mixing heights ranged from 100-300 m (300-1000 ft.) in the morning increasing to 150-450 m (500-1500 ft.) by midday and 300-600 m (1000-2000 ft.) by late afternoon (Page 78). The morning temperature sounding at Los Angeles International Airport showed a surface-based inversion extending to 150 m (500 ft.) with a strength of 8° C. The inversion base had lifted to about 900 m (3000 ft.) by noon and the temperature difference through the inversion had decreased to 7° C. The morning aircraft sounding at Flabob Airport near Riverside showed a surface inversion up to 300 m (1000 ft.) with a difference of 11° C. The inversion was gone by 1115 PST but there was still a relatively stable layer above 450 m (1500 ft.).

On the morning of 30 September there was a weak southeasterly flow throughout the Los Angeles Basin and weak northeast to northwest winds in the eastern Basin. By late morning the winds were increasing and shifting to south to southwest in the Los Angeles Basin and westerly in the eastern Basin. This flow persisted through the day.

Stratus clouds and fog covered the Basin except for the San Bernardino-Riverside area and visibilities were generally six miles or less. The low clouds and fog cleared by 1200 PST but visibilities were still low throughout the Basin. By late afternoon the visibilities increased along the south coast as the sea breeze swept out the smog. Visibilities of fifteen miles at Long Beach and nine miles as far inland as Ontario were reported.

Mixing heights ranged from 300 to 600 m (1000 to 2000 ft.) over most of the Basin during the day (Page 79).

The inversion base at Los Angeles International Airport was a 600 m (2000 ft.) in the morning with a temperature difference of 10° C. The base lowered to about 450 m (1500 ft.) by noon with a temperature difference of 9° C.

Pollution potential was classified as Moderate.

DESCRIPTION OF TRACER RESULTS

LOS ANGELES SOURCE AREA

Most of the tracer from the Los Angeles source area moved northward into the San Fernando Valley during the early part of the day with a small fraction moving eastward along the base of the San Gabriel Mountains (Page 81) stretching as far as the San Bernardino area by 1800 PST.

This secondary tracer cloud remained along the base of the San Gabriel Mountains during the night with some movement southeastward as far as March Air Force Base by 2400 PST. The next day the tracer cloud remaining moved into the Cajon Pass and mountain areas except for a small residual cloud centered near Upland.

TORRANCE SOURCE AREA

Tracer from the Torrance area moved predominantly northward to the San Fernando Valley and the San Gabriel Mountains. A portion of the cloud extended eastward toward Santa Ana and through the Santa Ana Canyon (Page 85). The cloud reached as far as San Bernardino and south-eastward into the San Jacinto Valley by late afternoon. A residual cloud remained in the Long Beach area during the afternoon but moved northeastward during the evening and stagnated along the base of the San Gabriel Mountains during the night. Residual tracer clouds remained in the Pasadena and Upland areas the next morning but dissipated during the day (Page 87).

SANTA ANA SOURCE AREA

Tracer from the Santa Ana area moved eastward through the Santa Ana Canyon southeastward as far as March Air Force Base by 1500 PST (Page 89).

A smaller portion of the cloud spread northeastward into the San Bernardino Mountains. The major portion of the tracer moved southeastward through the San Jacinto and Perris Valleys during the late afternoon and evening and the tracer had moved off the map area by the following morning.

LONG BEACH (elevated) SOURCE

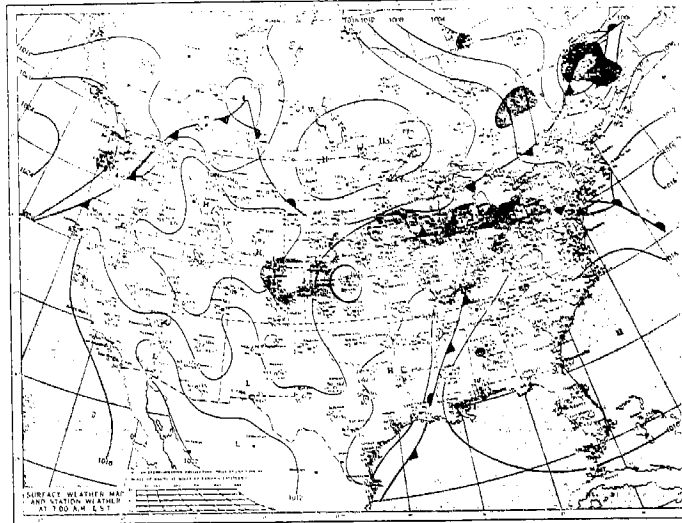
Tracer from the elevated source moved northward toward the San Fernando Valley during the morning of the first day with a secondary portion of the plume moving eastward as the tracer became mixed downward into the surface layer during the day (Page 93). The pattern was very similar to the Torrance source. The tracer extended as far east as Riverside and San Bernardino by 1500 PST. The tracer cloud then branched with a portion moving northward through the Cajon Pass and another south-eastward into the Perris and San Jacinto Valleys. Residual clouds remained in the Los Angeles area, the San Gabriel Canyon and March Air Force Base during the night. The tracer cloud moved northeast into the mountain area the following day (Page 95).

NORMALIZED OXIDANT

The Normalized Oxidant maps for the first twelve hours of the test day indicate a pattern consistent with transport of polluted air from west to east. The south coastal plain exhibited a deviation index greater than unity for the morning periods while the eastern Basin was less than unity. By afternoon the effects of the sea breeze could be seen, clearing the coastal areas. By late afternoon most of the western Basin was below unity except for an extension covering the West Los Angeles area. The eastern Basin had also been reduced in the Pomona and Ontario area, but remained well above unity in the Riverside-San Bernardino region.

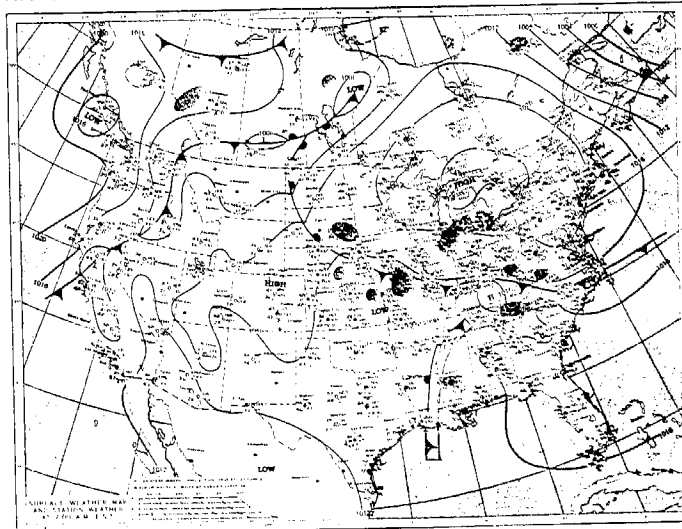
SATURDAY, SEPTEMBER 29, 1973

75



Surface Weather for Air Tracer Test B at
4:00 A.M. PST on 29 and 30 September 1973

SUNDAY, SEPTEMBER 30, 1973

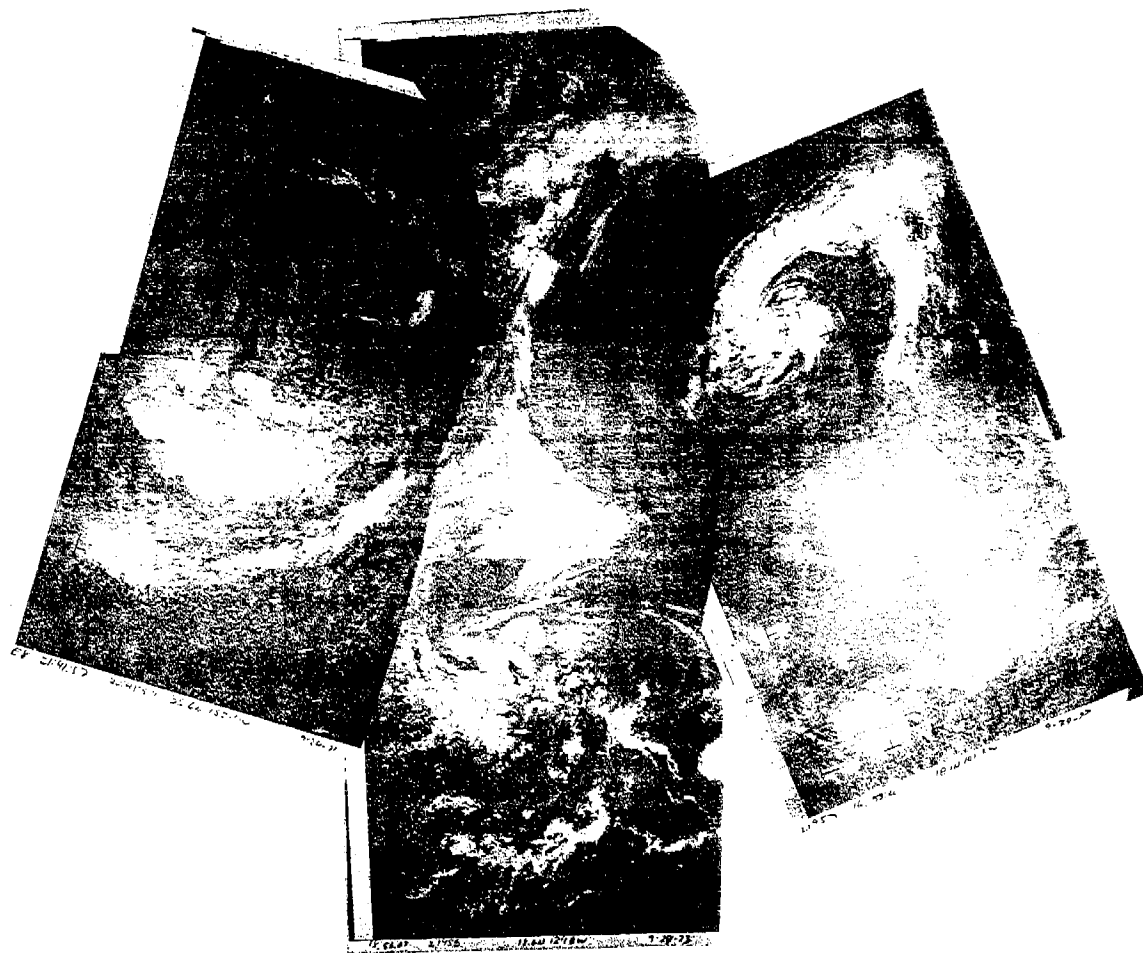


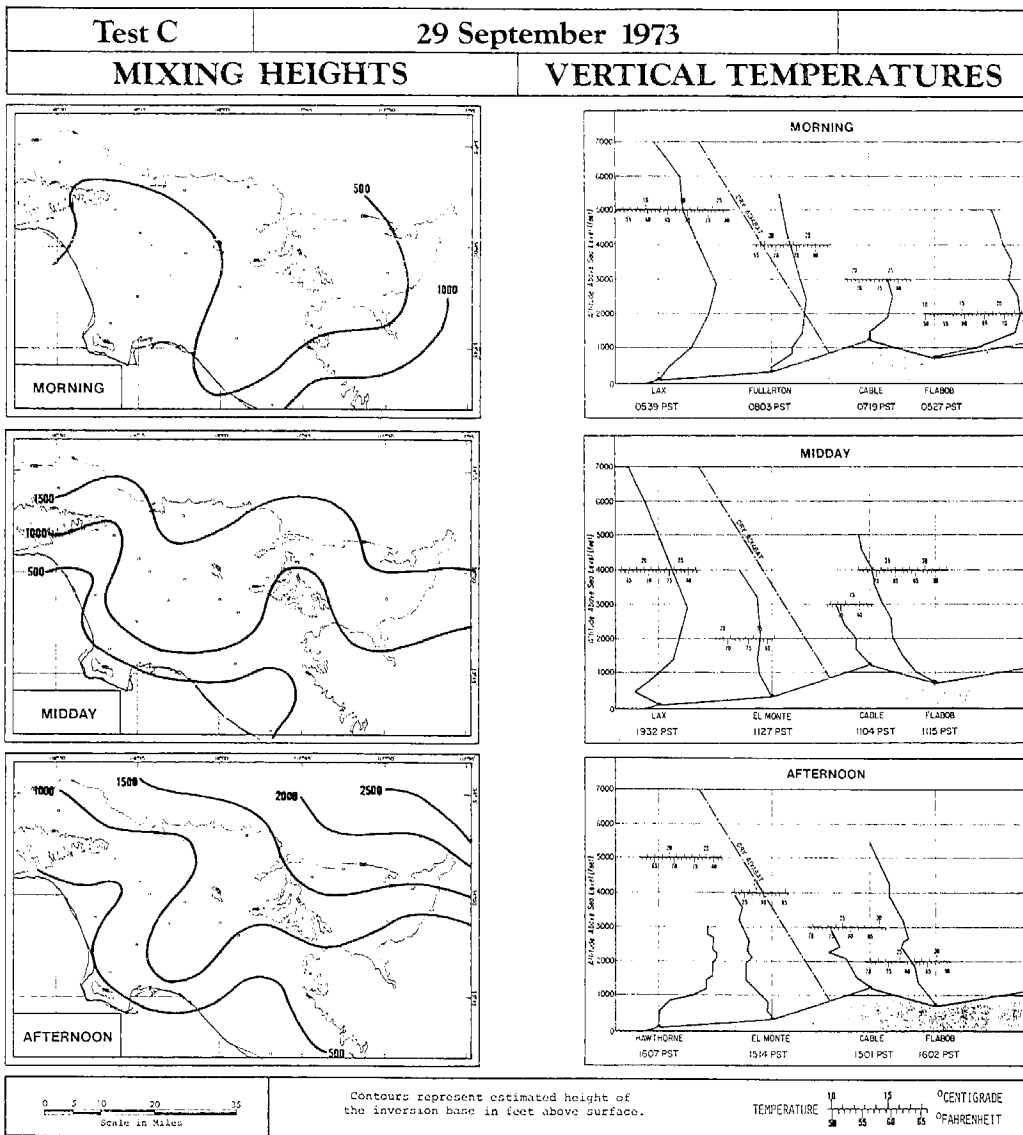
WEATHER SATELLITE MOSAIC

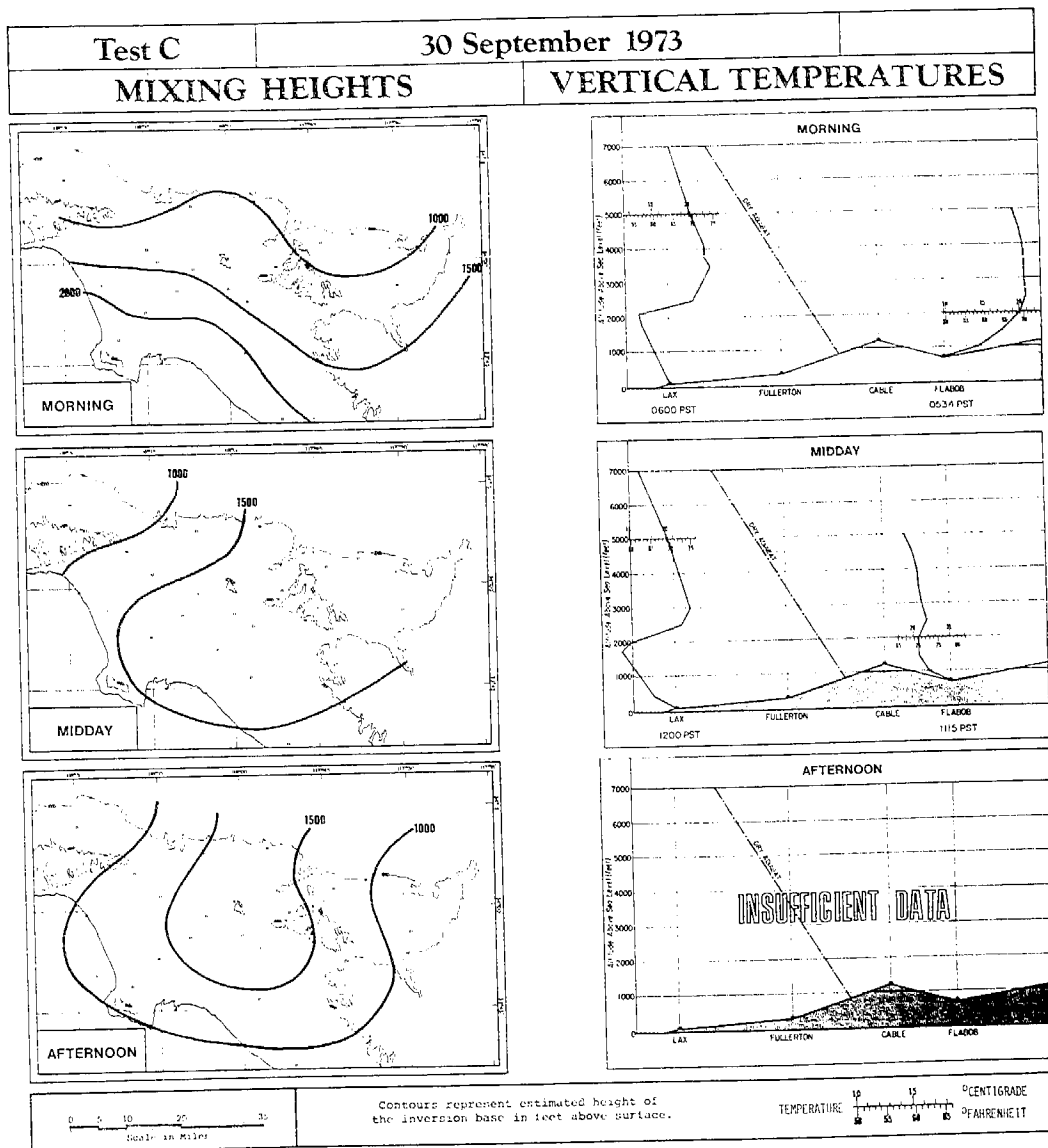
SEPTEMBER 29, 1973

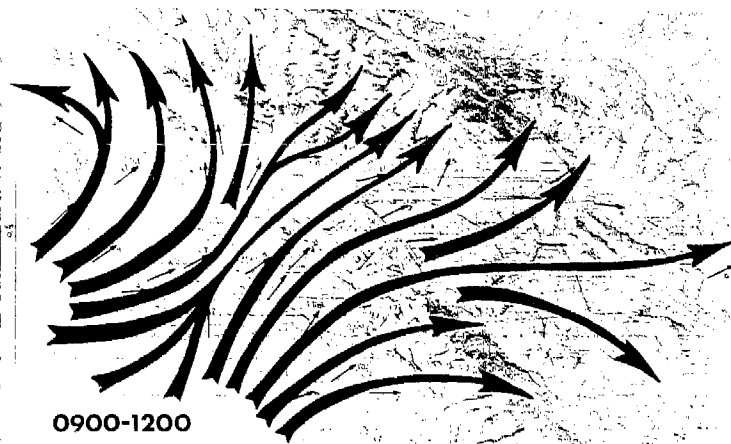
California and the Baja Peninsula are visible in the central portion of the photograph. The complete mosaic is made up of several pictures taken on sequential orbits by the ESSA-8 weather satellite. Photos were taken between 0900 and 1400 PST on 29 September 1973 at an altitude of 600 statute miles. Electronic image enhancement was used to improve picture quality. Visible wave lengths were used so the light areas represent cloud formations. Note that although a broad area of stratus clouds lie just off the Southern California coast, the land area of the South Coast Air Basin is clear.

Satellite photographs courtesy of National Weather Service.







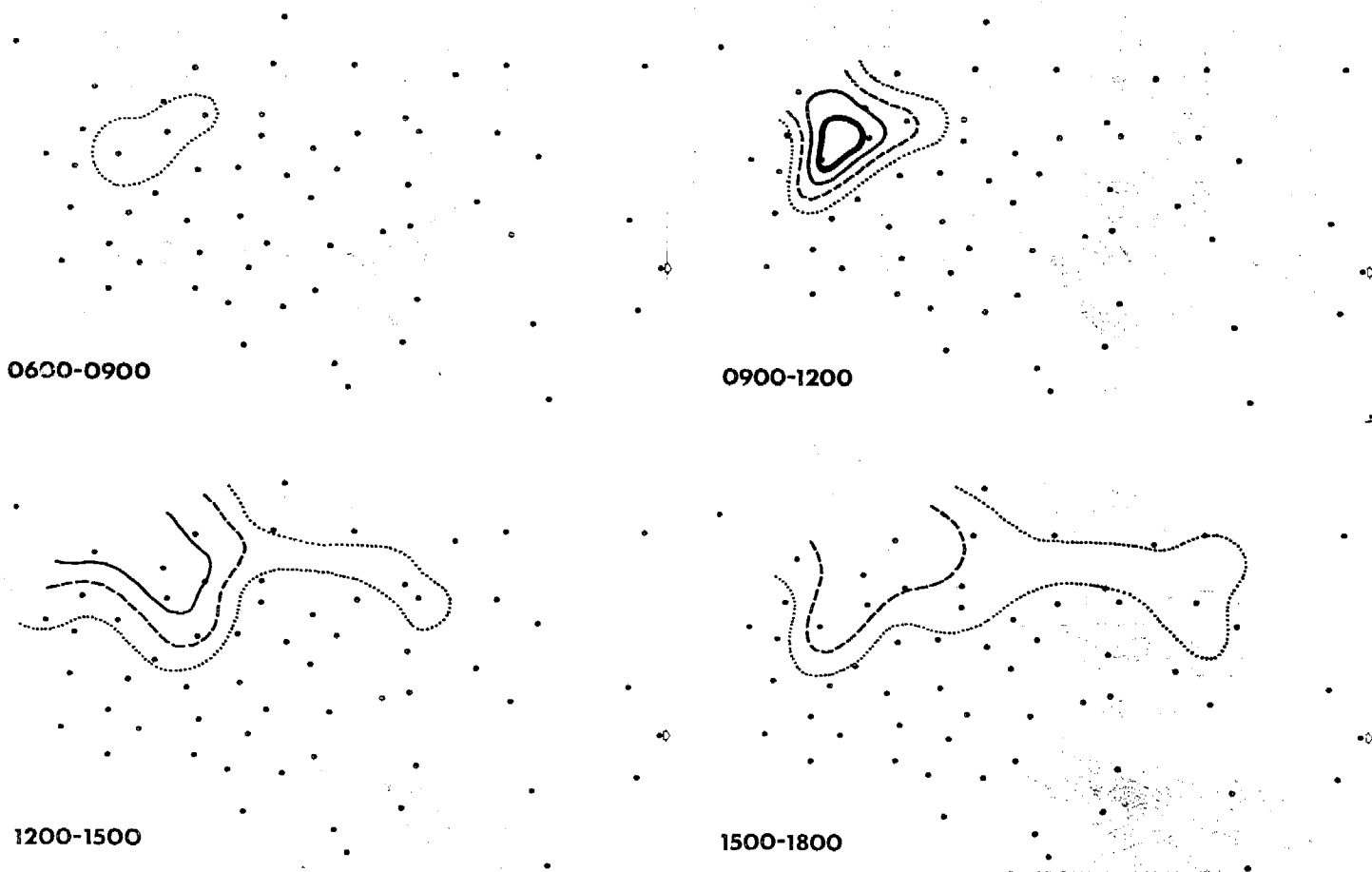


WIND AND CURRENT STREAMLINES
Map 1011 - Average Streamlines for the 1011-1012 Period

Wind vectors computed by averaging hourly values for the time periods noted. Both surface and Pilot measurements were used during the daylight hours.

0 5 10 20 30
Map Scale in Miles





TIME: ARE PACIFIC STANDARD TIME

Map Grid - Universal Transverse Mercator Grid - 10,000 Meters

Contours represent an effective average concentration of tracer material from a normalized source of 5×10^{14} particles.

..... = 1 - - - - - = 10 ——— = 100 ——— = 1000
Number of particles per cubic meter.

0 5 10 20 30
Map Scale in Miles





TIMES ARE PACIFIC STANDARD TIME
Map 1214 - Continental Transverse Mercator 1214 - 12,000 Meters

Wind vectors computed by averaging hourly values for the time periods noted. Both surface and Pibal measurements were used during the daylight hours.

0 5 10 20 30
Map Scale in Miles



Test C

29-30 September 1973

Effective Tracer Concentration

LOS ANGELES SOURCE

83

1800-2400

0000-0600

0600-1200

1200-1800

TIME: ARE PACIFIC STANDARD TIME

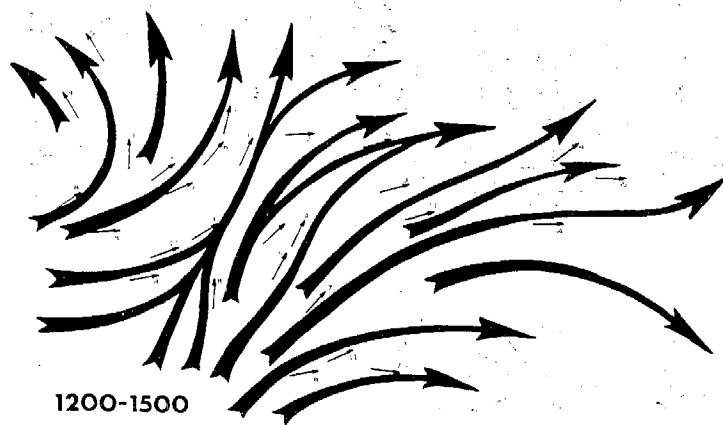
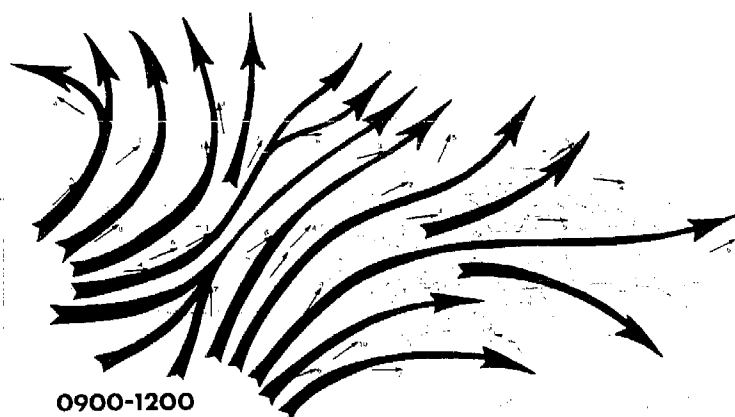
Map Grid - Universal Transverse Mercator Grid - 10,000 Meters

Contours represent an effective average concentration of tracer material from a normalized source of 5×10^{14} particles.

..... 1 * --- 10 --- 100 --- 1000
* Number of particles per cubic meter.

0 10 20 30
Miles Scale in Miles





TIME: ARE PACIFIC STANDARD TIME
Map Scale - 1:500,000 (Nautical Miles) 1:1,000,000 (Miles)

Wind vectors computed by averaging hourly values for the time periods noted. Both surface and Pibal measurements were used during the daylight hours.

0 5 10 20 30
Map Scale in Miles



0600-0900

0900-1200

1200-1500

1500-1800

TIME: AMT PACIFIC STANDARD TIME

Map Grid - Universal Transverse Mercator used - 10,000 Meters

Contours represent an effective average concentration of tracer material from a normalized source of 5×10^{15} particles.

1 10 100 1000

* Number of particles per cubic meter

0 10 20 30
Miles
Map Scale in Miles





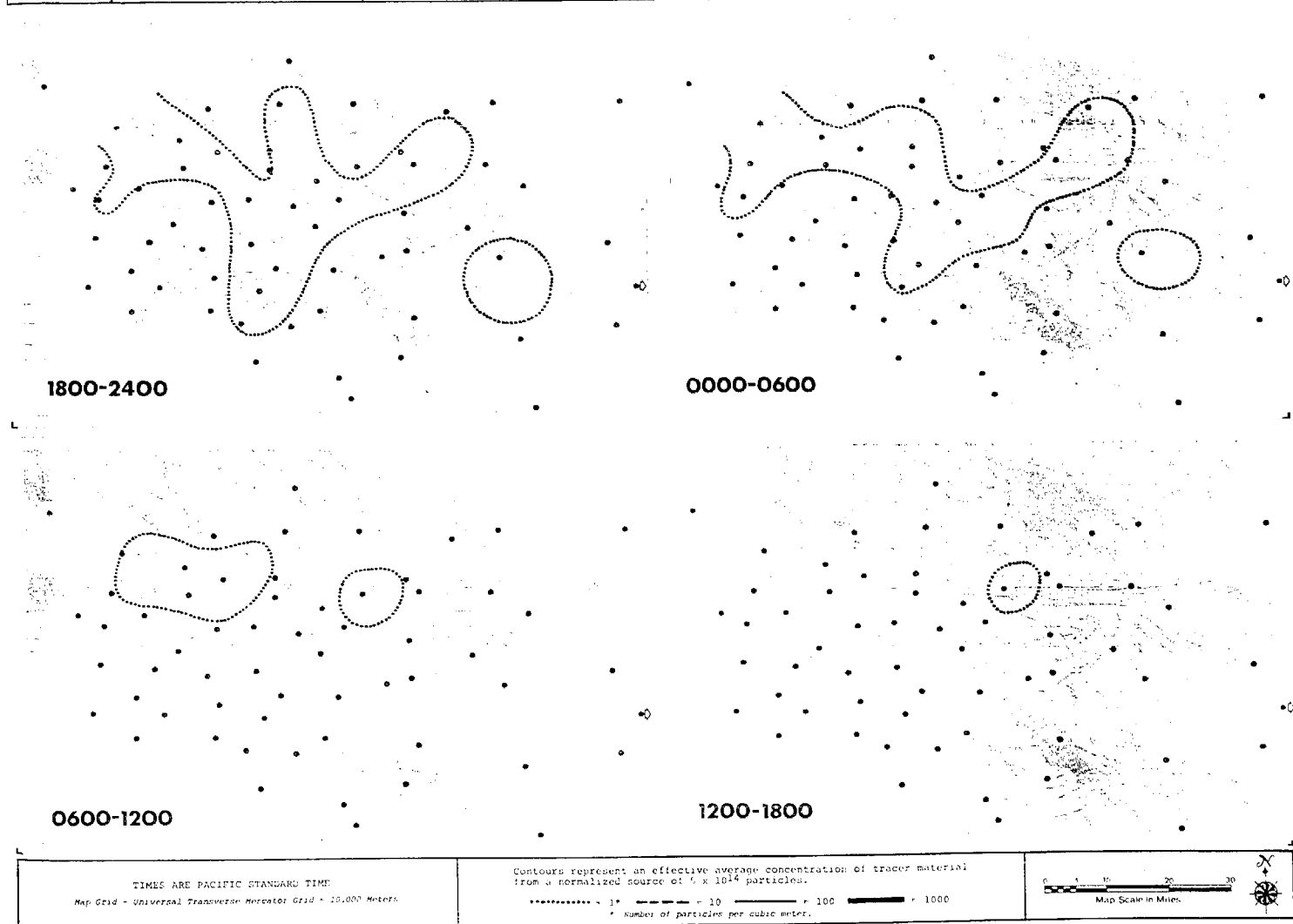
TIMES ARE PACIFIC STANDARD TIME
Map Grid - Universal Transverse Mercator Grid 10,000 Meters

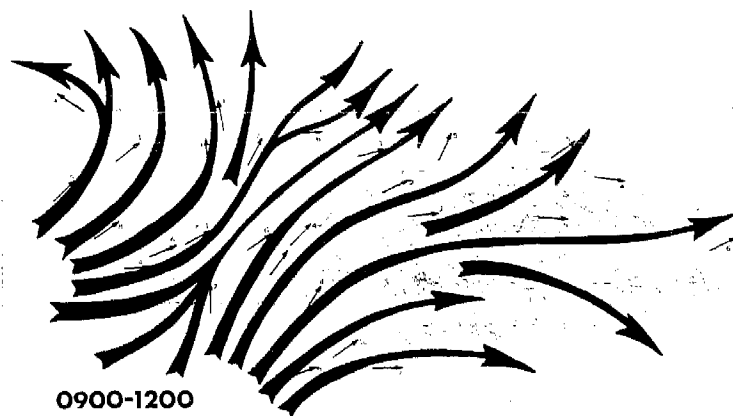
Wind vectors computed by averaging hourly values for the time periods noted. Both surface and Pibal measurements were used during the daylight hours.

0 5 10 20 30
Map Scale in Miles



Test C	29-30 September 1973	Effective Tracer Concentration	TORRANCE SOURCE	87
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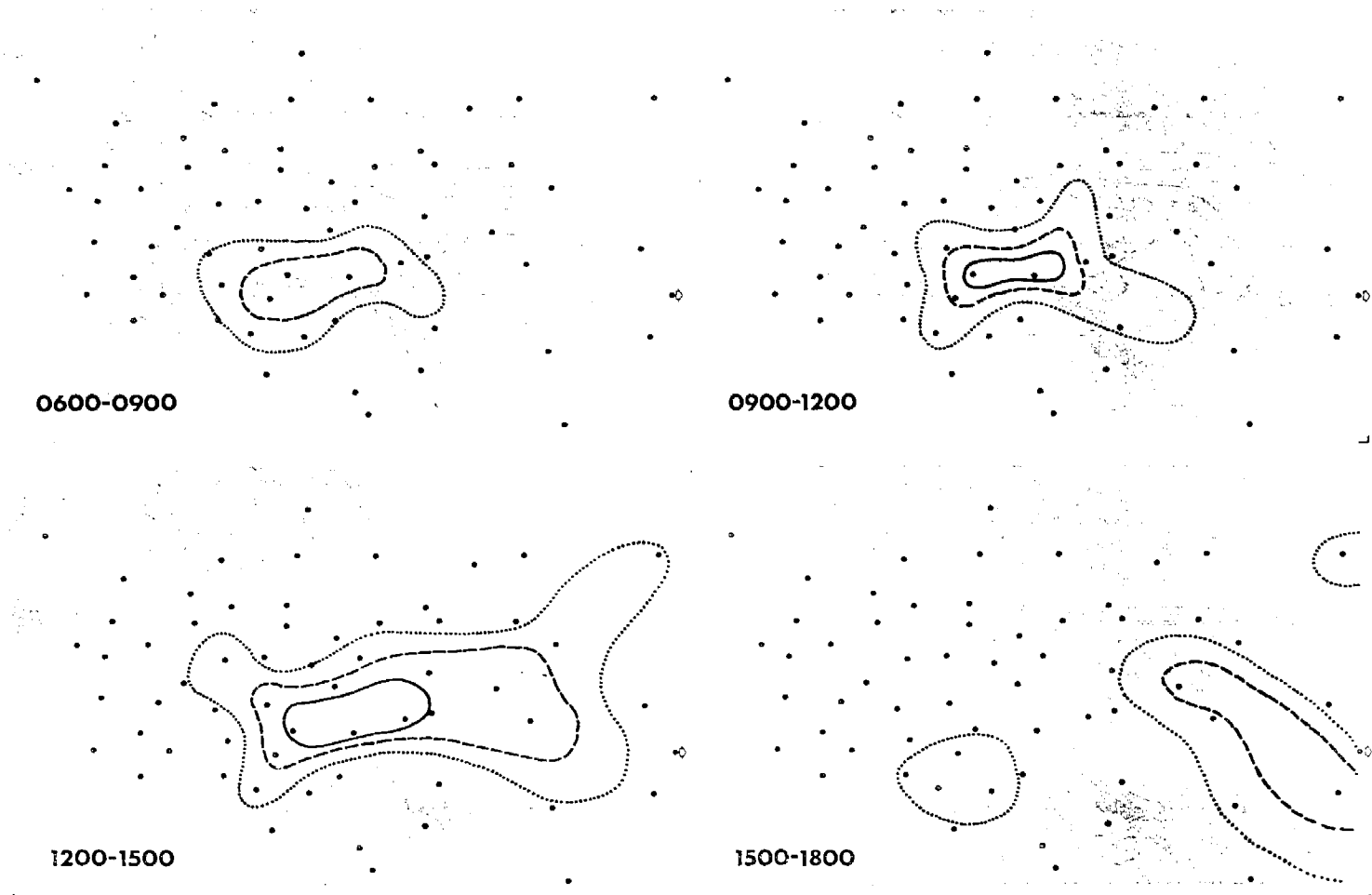
TIME: APT PACIFIC STANDARD TIME
MAP 1014 - OBSERVED TRANSMISSION AUGUST 1973 - 10,000 METERS



Wind vectors computed by averaging hourly values for the time periods noted. Both surface and Pibal measurements were used during the daylight hours.

0 10 20 30
Map Scale in Miles



Test C	29 September 1973	Effective Tracer Concentration	SANTA ANA SOURCE	 89
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<p>TIME: ARL PACIFIC STANDARD TIME</p> <p>Map Grid - Universal Transverse Mercator Grid - 10,000 Meters</p>	<p>Contours represent an effective average concentration of tracer material from a normalized source of 5×10^{15} particles.</p> <p> = 1 - - - - - = 10 ——— = 100 ——— = 1000 * Number of particles per cubic meter. </p>	<p>  Map Scale in Miles </p> <p>  </p>
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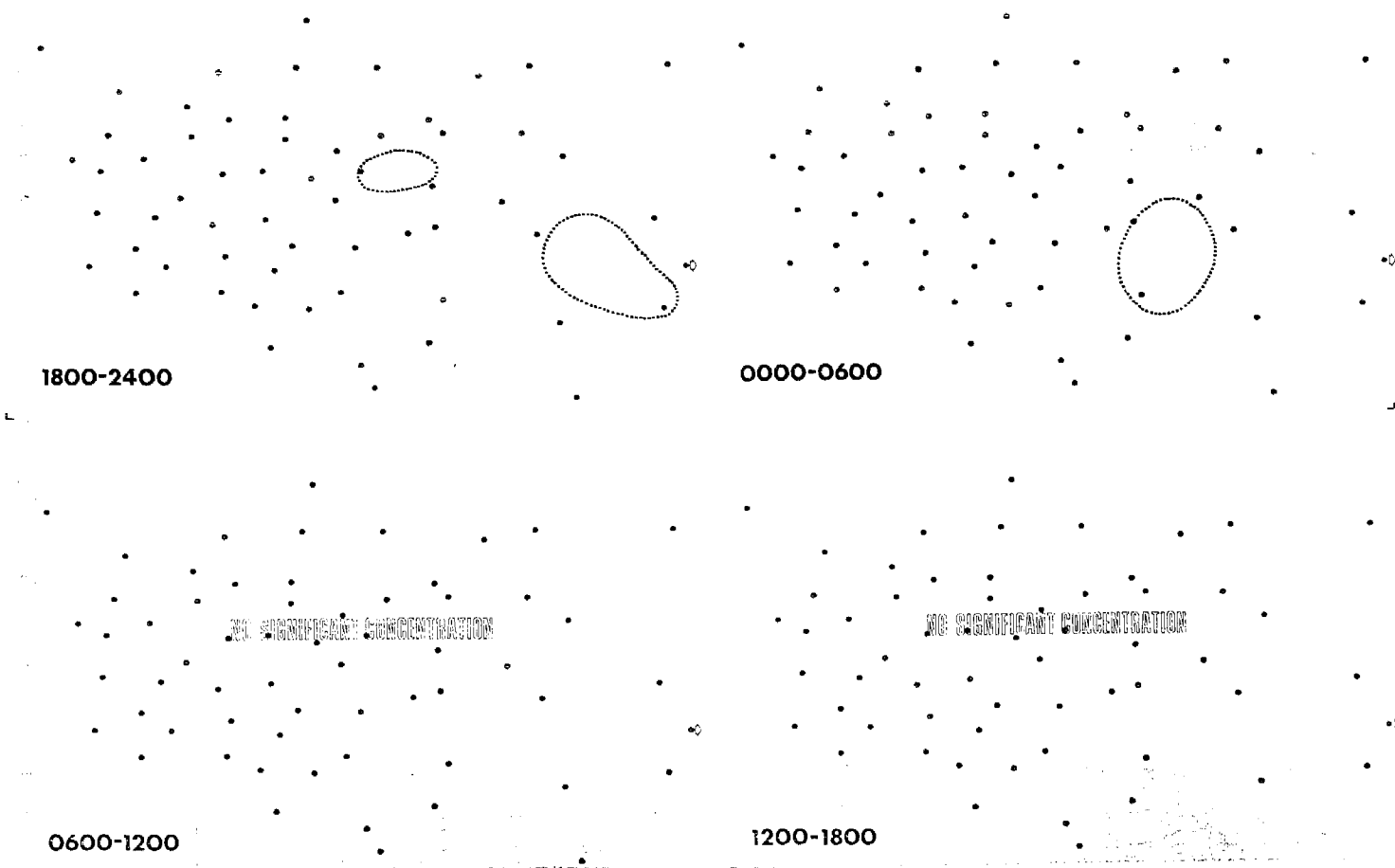
TIMES ARE PACIFIC STANDARD TIME

Map Scale - Universal Transverse Mercator (UTM) - 10,000 Meters

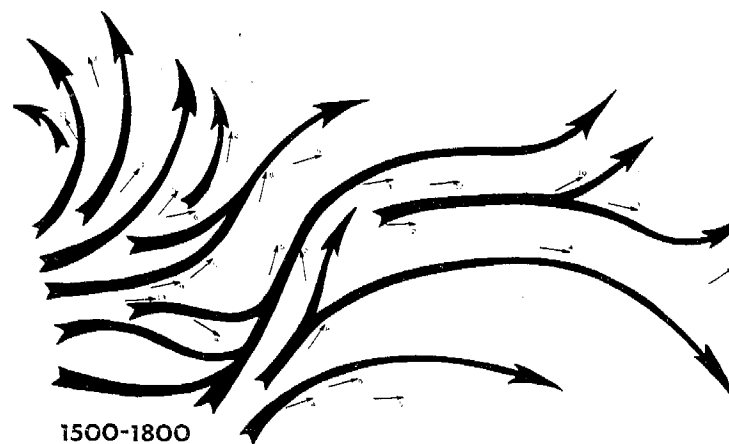
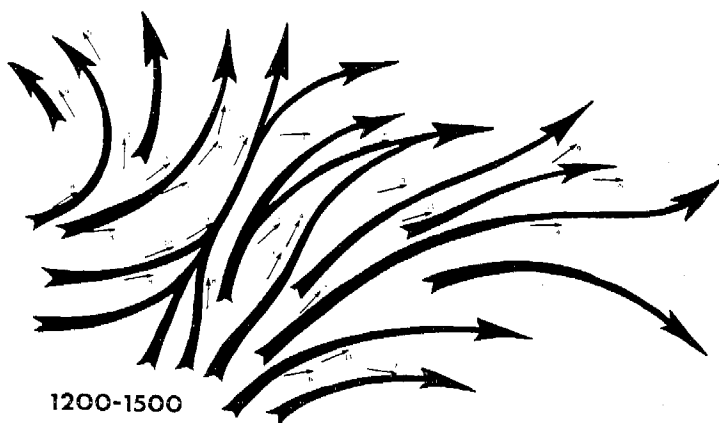
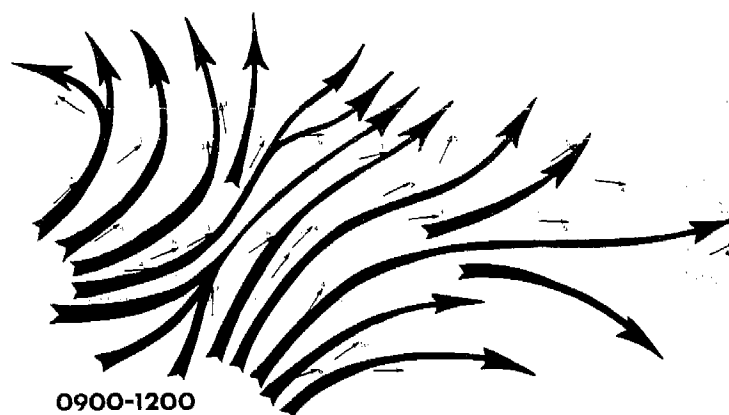
Wind vectors computed by averaging hourly values for the time periods noted. Both surface and Pibal measurements were used during the daylight hours.

0 5 10 20 30
Map Scale in Miles

Test C	29-30 September 1973	Effective Tracer Concentration	SANTA ANA SOURCE	ME 91
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<p>TIMES ARE PACIFIC STANDARD TIME</p> <p>Map Grid - Universal Transverse Mercator Grid - 10,000 METERS</p>	<p>Contours represent an effective average concentration of tracer material from a normalized source of 5×10^{14} particles.</p> <p>..... 1 10 100 1000</p> <p>* Amount of particles per cubic meter.</p>	<p>0 5 10 20 30</p> <p>Map Scale in Miles</p>
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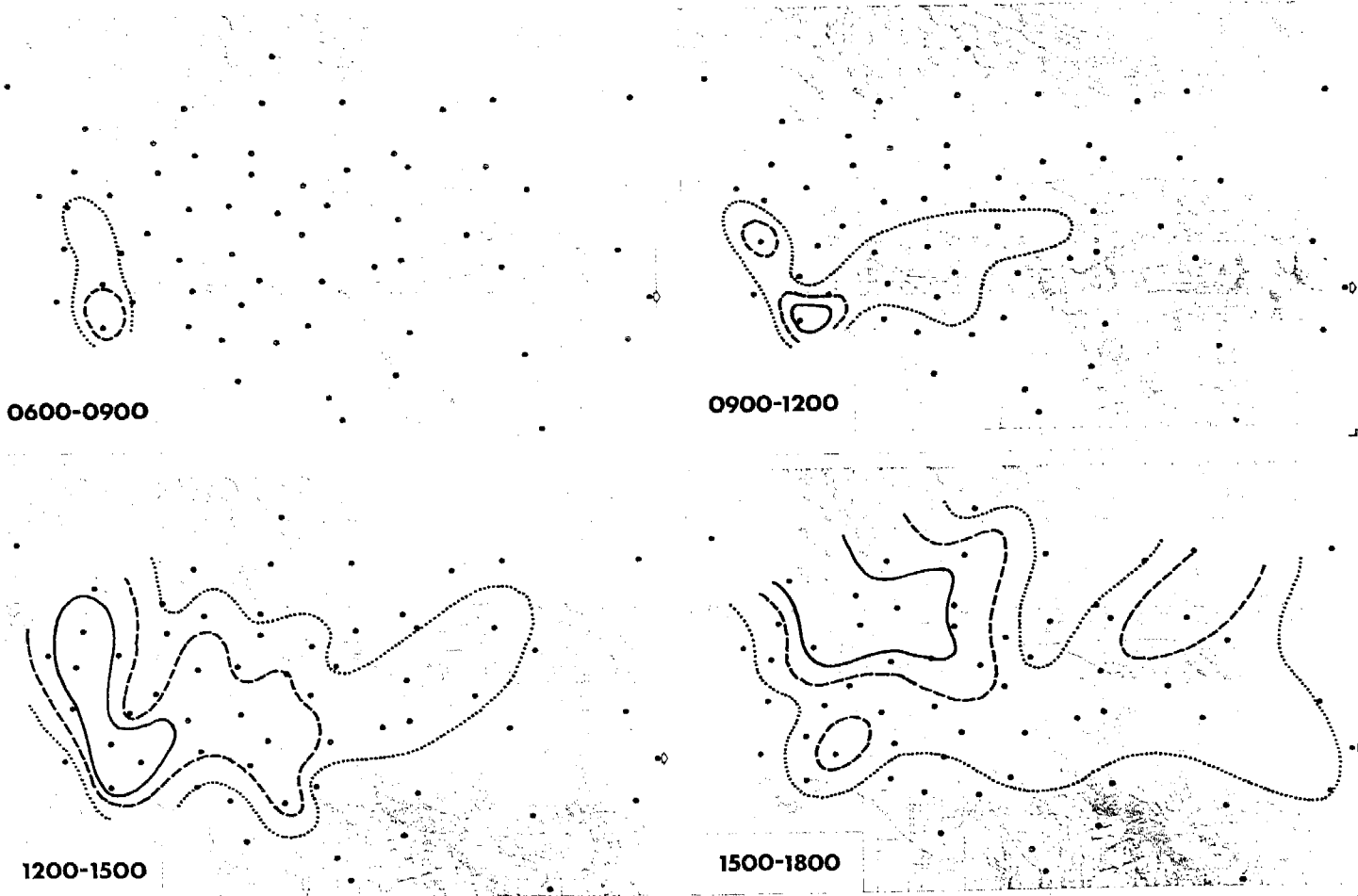


TIME IS PACIFIC STANDARD TIME
*Ap. 11.1 - Universal Transverse Mercator 11.1 - 10,000 Meters

Wind vectors computed by averaging hourly values for the time periods noted. Both surface and pilot measurements were used during the daylight hours.

0 5 10 20
Map Scale in Miles







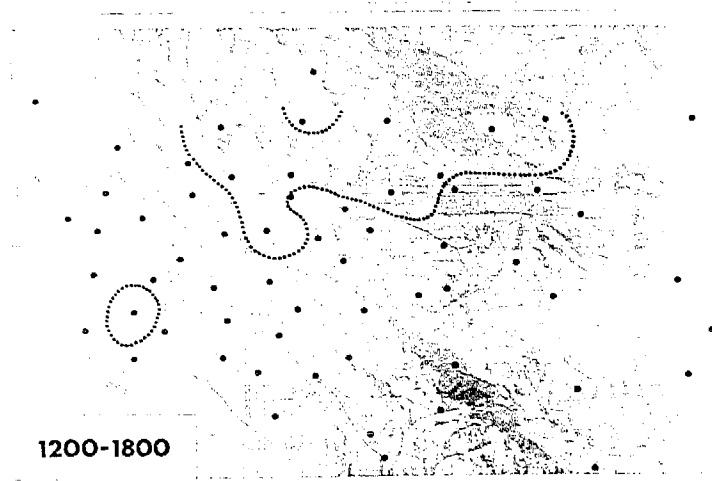
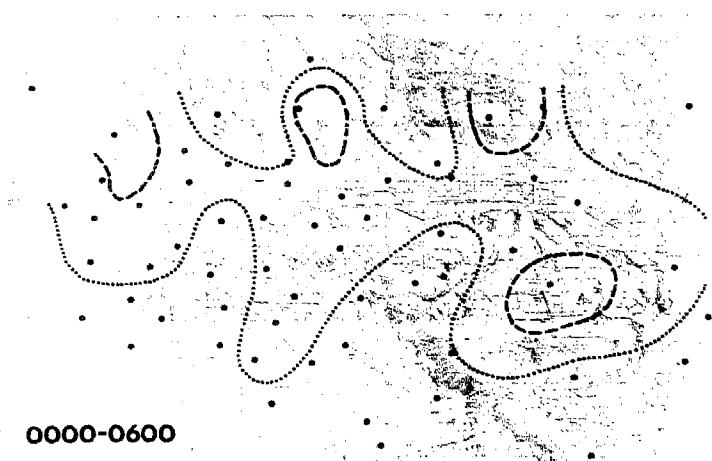
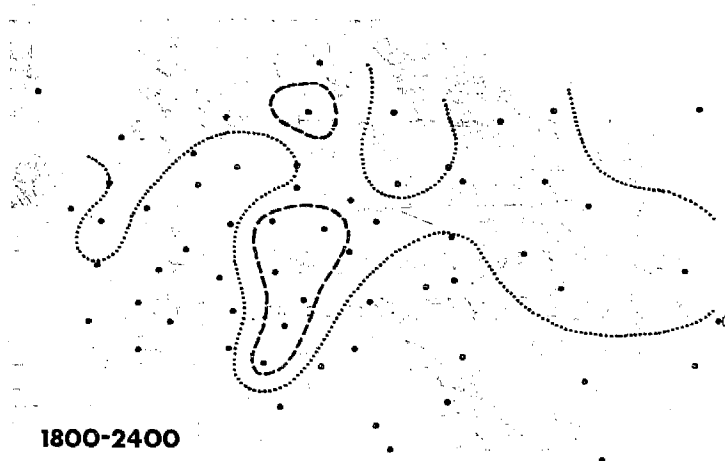
TIMEZ AND PACIFIC STANDARD TIME
Map 1111 - International Thunderstorm Mapster 1111 - 121200 Meters

Wind vectors computed by averaging hourly values for the time periods noted. Both surface and Pibal measurements were used during the daylight hours.

0 10 20 30
Map Scale in Miles



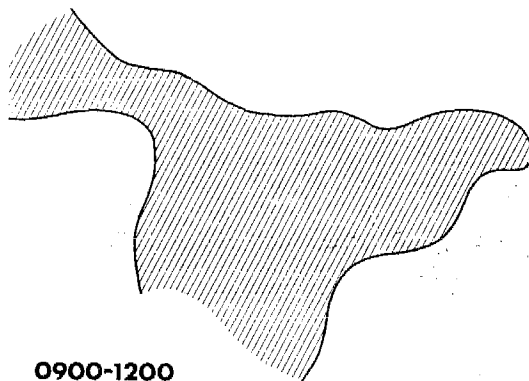
Test C	29-30 September 1973	Effective Tracer Concentration	LONG BEACH SOURCE ELEVATED	MEPRODAC 95
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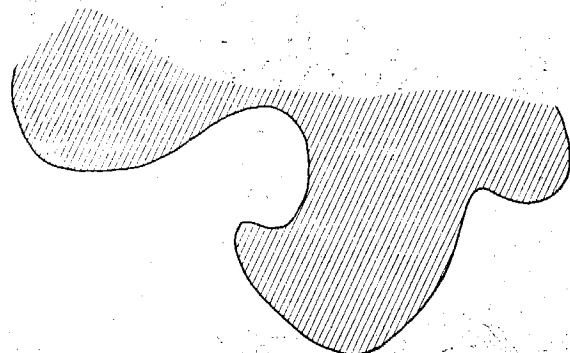
<p>TIMES ARE PACIFIC STANDARD TIME</p> <p>Map Grid - Universal Transverse Mercator Grid - 10,000 Meters</p>	<p>Contours represent an effective average concentration of tracer material from a normalized source of 5×10^{14} particles.</p> <p>..... = 10 ——— = 100 ——— = 1000</p> <p>* Number of particles per cubic meter.</p>	<p>0 5 10 20 30</p> <p>Map Scale in Miles</p>
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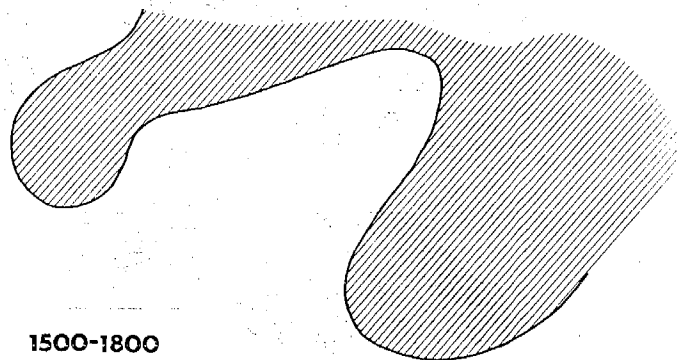
0600-0900



0900-1200

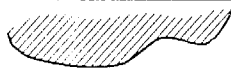


1200-1500



1500-1800

TIMES ARE PACIFIC STANDARD TIME
Map Grid - Universal Transverse Mercator Grid - 10,000 Meters



Shading indicates where deviation index is greater than unity.

0 5 10 20 30
Map Scale in Miles





SUMMARY

SUMMARY

COMPARISON OF METEOROLOGICAL CONDITIONS

During the summer and fall of 1972, conditions were less favorable than normal for the development of high concentrations of photochemical air pollutants. Temperature inversions were weak and mixing heights near the coast were low, suggesting that the inversion did not persist very far inland (Table 7). Wind speeds were lower than normal and transport of pollution inland was reduced.

In 1973 the temperature inversions were stronger, mixing heights were higher and wind speeds were higher than in 1972, giving greater transport of pollutants into the inland areas.

Pasquill Stability classes for the first day of each test are presented in Table 8. Frequencies of stability classes for three locations in the Los Angeles Basin are given in Table 9.

POLLUTION LEVELS

Table 10 lists the maximum hourly oxidant concentrations for a number of air quality monitoring stations in the South Coast Air Basin for test days in both the 1972 and 1973 test series.

A subjective but useful index of photochemical "smog" is eye irritation. Records have been kept by the Los Angeles Air Pollution Control District since 1956. A comparison of the long-term average of the number of days per year of different degrees of eye irritation is presented in Table 11.

TABLE 7
POLLUTION POTENTIAL PARAMETERS ON TEST DAYS

YEAR	TEST	DATE	TT(°C)*	ΔT(°C)*	HB(meters)*	OX(pphm)	POLLUTION POTENTIAL
1972	1	26 July	28.6	6.6	228	22	M
		27 July	31.4	9.2	140	18	H
	2	29 Aug	29.7	3.7	140	13	M
		30 Aug	23.5	0.2	480	14	M
	3	20 Sep	25.5	4.8	150	17	M
		21 Sep	28.5	5.0	90	18	M
	4	24 Oct	19.4	2.2	244	12	M
		25 Oct	<u>19.4</u>	<u>1.4</u>	<u>228</u>	<u>5</u>	M
	Average		25.8	4.1	212	15	
1973	A	3 Aug	25.0**	4.5	366**	16	M
		4 Aug	21.0	6.0	550	13	M
	B	13 Sep	23.0	10.3	760	12	M
		14 Sep	20.0	8.3	730	16	M
	C	29 Sep	25.0	6.5	152	19	M
		30 Sep	<u>22.7</u>	<u>8.7</u>	<u>490</u>	<u>13</u>	M
	Average		22.8	7.4	508	15	

* TT = Temperature at top of inversion, ΔT = Temperature differences through inversion, and HB = Height of inversion base.

** From MRI aircraft sounding at Hawthorne.

TABLE 8

PASQUILL STABILITY CLASSIFICATION OF TEST DAYS

TEST	DATE	TIME (PST)			
		0600-0900	0900-1200	1200-1500	1500-1800
A	3 Aug 1973	D	C	C	D
B	13 Sep 1973	D	D	D	D
C	29 Sep 1973	C	B	C	D
		0300-0900	0900-1500	1500-2100	
1	26 Jul 1972	C	B	C	
2	29 Aug 1972	D	D	D	
3	20 Sep 1972	C	C	C	
4	24 Oct 1972	D	C	D	

TABLE 9

FREQUENCIES (%) OF PASQUILL STABILITY CLASSES FOR THE MONTHS OF JULY, AUGUST, SEPTEMBER, AND OCTOBER AT LOS ANGELES, LONG BEACH AND LOS ALAMITOS

MONTH	CLASS	LOS ANGELES	LONG BEACH	LOS ALAMITOS	AVERAGE
July	A	0.27	3.63	5.00	2.97
	B	7.12	15.81	18.56	13.83
	C	20.75	15.65	16.22	17.54
	D	44.52	31.96	24.74	33.74
	E	11.02	8.74	2.99	7.58
	F	16.32	24.22	32.49	24.34
Aug.	A	0.05	1.83	3.76	1.88
	B	4.73	14.89	17.34	12.32
	C	18.52	14.57	16.05	16.38
	D	47.39	32.72	23.25	34.45
	E	11.77	11.13	3.28	8.73
	F	17.53	24.87	36.32	26.24
Sept.	A	0.00	1.36	1.86	1.07
	B	4.25	11.86	11.28	9.13
	C	11.94	13.75	13.44	13.04
	D	53.75	35.47	36.69	41.97
	E	11.42	9.06	3.69	8.06
	F	18.64	28.50	33.03	26.72
Oct.	A	0.00	0.78	1.69	0.82
	B	4.96	9.41	11.67	8.68
	C	13.37	12.07	13.17	12.87
	D	46.43	38.01	28.95	37.80
	E	11.18	9.41	3.52	8.04
	F	24.06	30.32	40.99	31.79

TABLE 10						
MAXIMUM HOURLY AVERAGE OXIDANT CONCENTRATION (pphm) ON 1973 TEST DAYS						
STATION	TEST A		TEST B		TEST C	
	August		September		September	
	3rd	4th	13th	14th	29th	30th
Anaheim	7	6	9	6	16	9
Azusa	21	15	13	20	28	17
Burbank	16	8	10	16	18	13
Costa Mesa	5	4	9	8	16	11
El Toro	5	4	6	5	10	8
La Habra	9	10	9	10	16	13
Lennox	3	2	7	5	8	7
Long Beach	4	3	5	5	8	5
Downtown Los Angeles	10	6	8	10	17	12
Norco-Prado Park	12	14	13	12	14	11
Pasadena-Walnut	19	15	11	19	23	14
Pomona	19	12	12	18	14	13
Reseda	18	19	14	19	16	15
Riverside ARB-UCR	23	21	16	19	17	13
Riverside-Magnolia	21	24	17	20	16	14
Riverside-Rubidoux	11	16	17	17	22	18
San Bernardino	21	16	19	21	18	14
Upland ARB	35	23	23	33	28	23
West Los Angeles	10	5	9	9	13	10
Whittier	5	6	7	9	9	7
Average	14	11	12	14	16	12

TABLE 10 (continued)								
MAXIMUM HOURLY AVERAGE OXIDANT CONCENTRATION (pphm) ON 1972 TEST DAYS								
STATION	TEST 1		TEST 2		TEST 3		TEST 4	
	July		August		September		October	
	26th	27th	29th	30th	20th	21st	24th	25th
Anaheim	19	15	15	9	13	23	5	3
Azusa	25	17	10	16	19	13	15	6
Burbank	23	22	9	15	13	15	6	6
Costa Mesa	10	10	16	10	ND	ND	3	4
Downtown Los Angeles	23	20	20	12	11	17	11	5
Fontana	24	10	9	10	13	16	14	4
La Habra	36	17	22	13	27	20	8	3
Lennox	6	5	9	6	9	17	4	4
Long Beach	6	7	10	6	4	11	4	4
Los Alamitos	11	10	12	4	12	17	4	5
Ontario	17	7	7	9	7	9	19	6
Pasadena	24	19	20	18	16	15	14	9
Pomona	25	10	6	13	15	18	14	5
Prado Park	27	18	15	11	26	23	15	6
Redlands	21	10	5	9	19	16	11	2
Reseda	24	16	8	14	7	10	10	5
Riverside	ND	20	10	14	37	27	22	4
San Bernardino	21	10	5	12	13	16	11	3
West Los Angeles	16	12	14	10	11	16	10	6
Whittier	27	16	22	12	23	21	8	5
Average	20	14	12	11	16	17	10	5

TABLE 11

EYE IRRITATION RECORDS IN THE LOS ANGELES BASIN*

Maximum Degree of Eye Irritation Reported in the Los Angeles Basin	Number of Days Eye Irritation Reported ^{a)}					
	Average 1956-1973	1969	1970	1971	1972	1973
None	164	134	133	145	128	126
Light	85	68	67	73	92	85
Moderate	54	54	47	43	31	35
Heavy	24	15	20	9	2	4

a) Prior to 1966, eye irritation observations were made daily. In subsequent years no reports were made on weekends and holidays unless heavy smog is forecast. Air monitoring stations are then specially staffed.

* From monthly and annual reports, "Meteorology, Air Pollution Effects and Contaminant Maxima of Los Angeles County," Air Pollution Control District, County of Los Angeles.

It is evident from Table 11 that the number of days with moderate or heavy eye irritation in 1972 was well below the long-term average. The number of days with moderate or heavy eye irritation increased slightly in 1973 but was still well below that for preceding years. The decreased frequency of days with moderate to heavy eye irritation could at least partially be due to the increased effectiveness in controlling emissions from motor vehicles and stationary sources. This appears to be the case during the period 1963-1972 for the South Coast Air Basin as a whole (Mills, Holland and Duckworth 1974) although maximum oxidant concentrations have increased at Riverside during this period.

GENERALIZED AIR TRACER PATTERNS

In all tests, transport of labeled air masses was extensive. Tracer material from morning releases in the Los Angeles area generally spread northward into the San Fernando Valley with smaller portions traveling east along the base of the San Gabriel Mountains. A good example of this pattern can be seen on Pages 80 through 83.

Movement of tracer released in the Torrance area was highly sensitive to the position of the Palos Verdes convergence zone. The tracer either moved north or east-northeast depending upon the position of the source in relation to the convergence zone at that time. In two of the tests a bifurcated pattern (Pages 103 and 107) can be seen suggesting that at least part of the source area was on both sides of the convergence zone at some time. As with the Los Angeles source, if it went northward, the labeled air mass from Torrance often separated at the mouth of the San Fernando Valley with a portion moving east along the base of the San Gabriel Mountains.

Air labeled with a morning release of tracer in the Santa Ana area generally moved eastward through the Santa Ana Canyon and then southeast. This pattern is most dramatically seen in Test C (Page 89). Even in cases where the predominant flow was to the east, a small portion of the tracer could often be seen moving north and up to the base of the San Gabriel Mountains.

In some of the 1972 tests (2 and 3) the generalized patterns outlined above were disrupted by winds from the north. In those cases there was much more southward movement observed, with a resulting distortion of the overall patterns.

The elevated source in the Long Beach area was only run during the 1973 series. In general, the labeled plume did not interact strongly with the sampling array until some time after dispersal. Movement was influenced by upper level winds. However, when the labeled plume eventually diffused to ground level, the overall pattern was similar to the Torrance-based ground-level release.

Elevated sources, such as industrial stacks, are primarily designed to reduce ground level concentrations of pollutant emissions. However, it was found that when vertical mixing in the atmosphere is well developed, ground-level concentrations at long distances are comparable to those from equivalent ground-level sources. In excess of 25 Km, tracer concentrations from the Long Beach elevated source and the nearby Torrance ground-level source showed little difference (Pages 85 and 93).

The effect of the interaction between surface and upper level winds can be seen on Pages 85 and 93. The main body of the labeled plume seemed to follow the upper level winds (Appendix A) but there was a distinct extension of the pattern caused by surface winds which were approximately at right angles to the flow aloft.

In the same vein, the northward movement of tracer released at ground level in Torrance can best be explained by mechanisms involving the same upper level winds transporting the stack plume. This similarity implies a means of interchange between levels.

A similar mechanism must be called upon to explain the rapid movement of a portion of the air mass labeled at ground level in Santa Ana in Test B. Tracer material was observed in the San Bernardino Mountains in significant concentration without corresponding values being observed at any time at ground-level stations along the route (Page 108). Similar results were seen in the 1972 Test 2 (Page 104).

It is evident that upper level winds play an important role in the

transport and diffusion of polluted air and surface wind information alone is insufficient to predict the patterns of movement which result.

POLLUTION CARRYOVER

The fraction of tracer-labeled air masses remaining within the sampling network from one day to the next was computed for each source for each test. There is a dramatic difference between the 1972 and 1973 test series with regard to residual pollution. There was a wide variation in carryover for the different sources and tests, but approximately 14% of the tracer released in tests of the 1972 series remained in the Basin overnight, while only approximately 4% remained in the 1973 test series (Table 12).

It was also noted that concentrations of residual tracer from the elevated Long Beach source appeared significantly higher than from ground-level sources. The difference could be attributed to a larger portion of tracer from the elevated source being caught in the more stable layers of the atmosphere aloft. This material would then be present in higher concentration the next day when vertical mixing would bring it to the surface sampling network.

TABLE 12						
TRACER MATERIAL CARRYOVER* FROM FIRST TO SECOND TEST DAY 1973 AND 1972						
TEST	DATE	NO. STATIONS	SOURCE AREA			
			LOS ANGELES	TORRANCE	SANTA ANA	LONG BEACH
A	3-4 Aug. 1973	41	0.004	0.046	0.016	0.155
B	13-14 Sep. 1973	49	0.050	0.018	0.019	0.076
C	29-30 Sep. 1973	42	0.014	0.009	0.017	0.046
Average			0.023	0.024	0.017	0.092
Standard Deviation			0.020	0.024	0.002	0.046
Average for All Sources				0.039		
Standard Deviation				0.040		
RATIOS OF TOTAL FP COUNTS IN TEST AREA FOR DAY 2 DIVIDED BY TOTAL FOR DAY 1						
TEST NO.	DATE	NO. STATIONS	SOURCE AREA			
			LOS ANGELES	TORRANCE	SANTA ANA	
1	26-27 July, 72	50	0.172	0.086	0.045	
2	29-30 Aug., 72	51	0.158	0.268	0.204	
3	20-21 Sep., 72	52	0.052	0.179	0.093	
4	24-25 Oct., 72	41	0.145	0.068	0.199	
Average			0.132	0.150	0.135	
Standard Deviation			0.046	0.080	0.069	
Average for All Sources				0.139		
Standard Deviation				0.067		

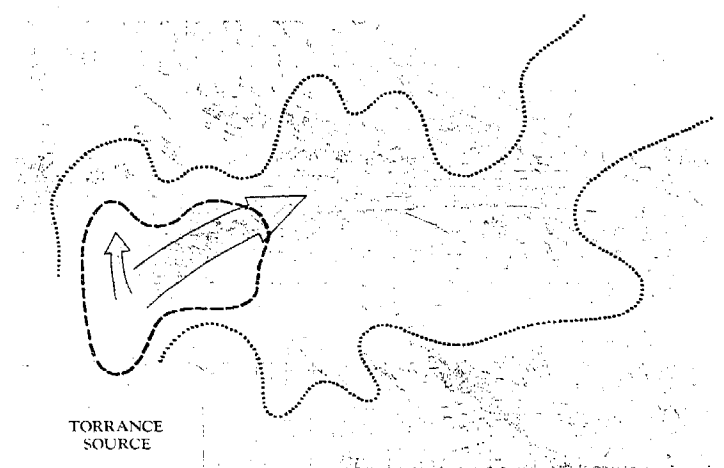
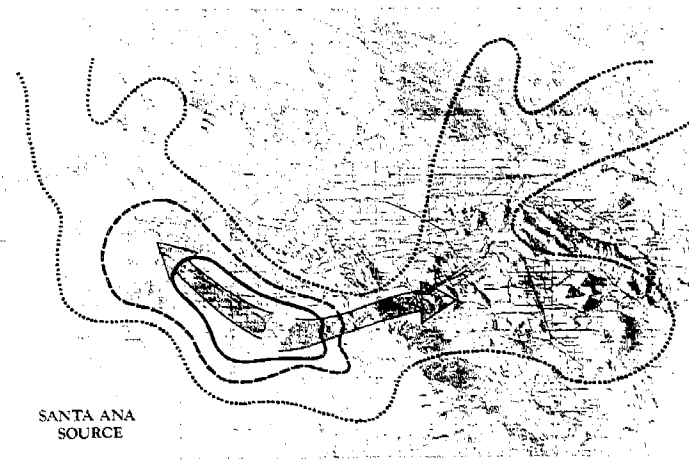
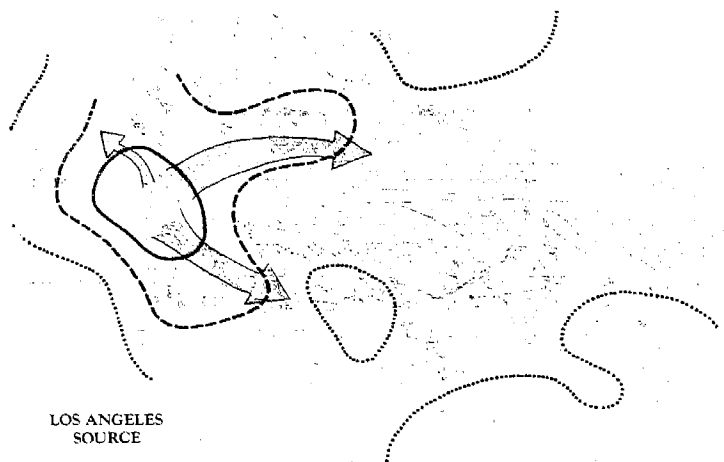
*Ratios of Total FP Counts between 0600 and 1800 PST each day.
Tracer remaining in test area for second test day divided by
total for first test day.

Test 1

26-27 July 1972

TRACER TEST SUMMARY

103



TRACER RELEASED FROM 0400 - 0600 PST

Contours represent an effective average concentration of tracer material from a normalized source of 5×10^{14} particles.

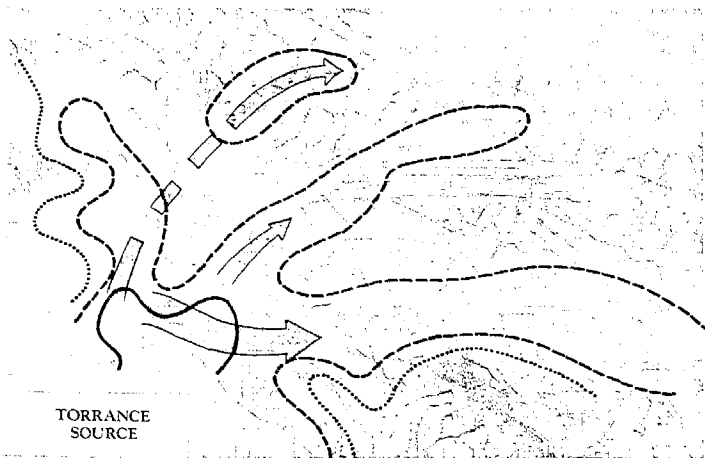
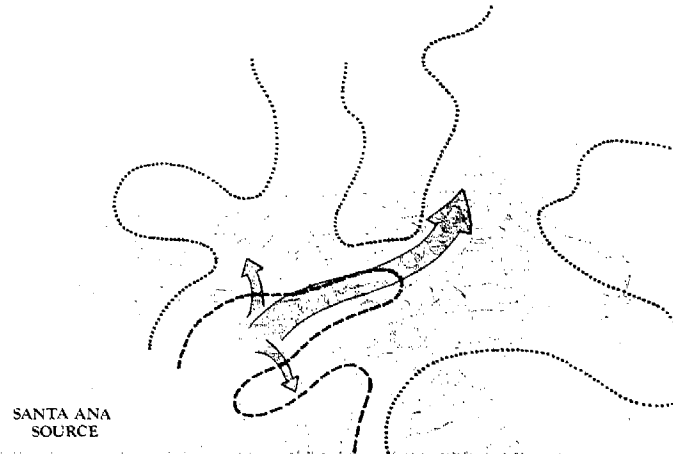
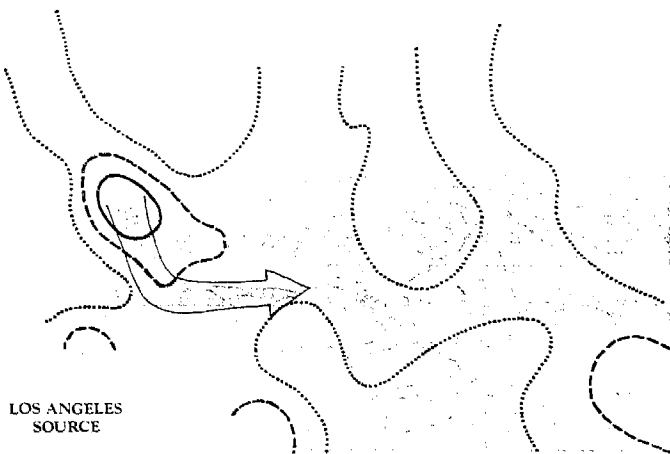
..... < 10
 - - - - - < 100
 ————— < 1000

* Sum of particles per cubic meter.

Indicates predominant trajectory

0 5 10 20 30
 Map Scale in Miles





TRACER RELEASED FROM 0400 - 0600 PST

Contours represent an effective average concentration of tracer material from a normalized source of 5×10^{14} particles.

..... - 1* - - - - - 10
- - - - - 100 - - - - - 1000

* Number of particles per cubic meter.



Indicates predominant trajectory

0 5 10 20 30
Map Scale in Miles



Test 3 20-21 September 1972

TRACER TEST SUMMARY

105

LOS ANGELES
SOURCE

SANTA ANA
SOURCE

TORRANCE
SOURCE

TRACER RELEASED FROM 0400 - 0600 PST

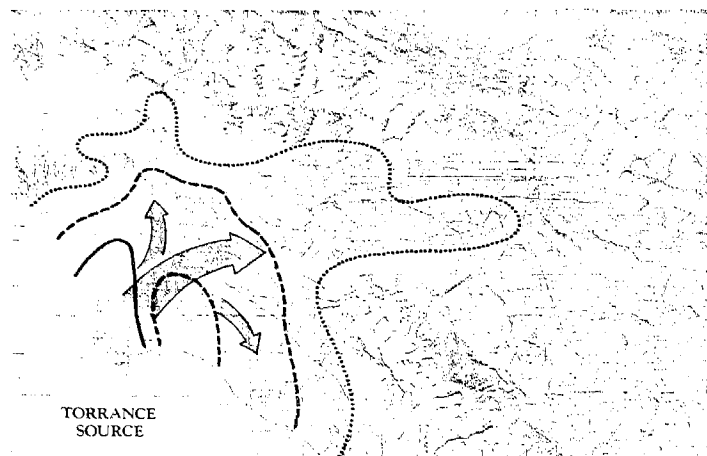
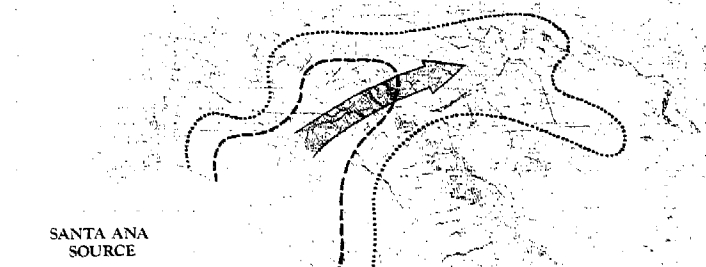
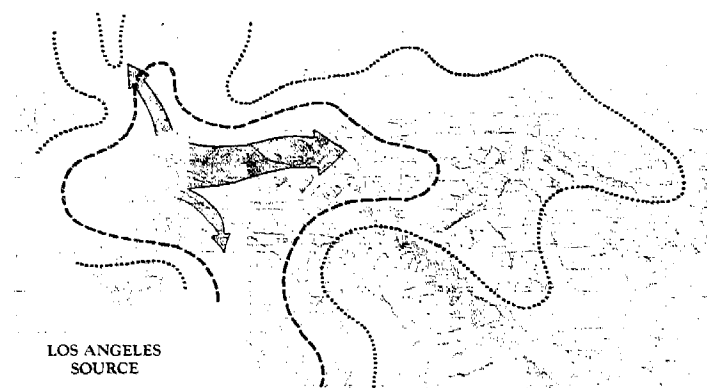
Contours represent an effective average concentration of tracer material from a normalized source of 5×10^4 particles.
..... = 1
———— = 10
———— = 100
———— = 1000
* Number of particles per cubic meter.



Indicates predominant trajectory

0 10 20 30
Map Scale in Miles





TRACER RELEASED FROM 0400 - 0600 PST

Contours represent an effective average concentration of tracer material from a normalized source of 5×10^{14} particles.

..... = 1* - - - - = 10
- - - - = 100 - - - - = 1000

* Number of particles per cubic meter.



Indicates predominant trajectory

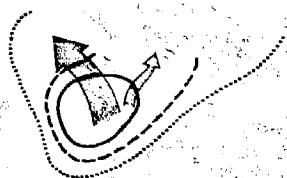
0 5 10 20 30
Map Scale in Miles

Test A

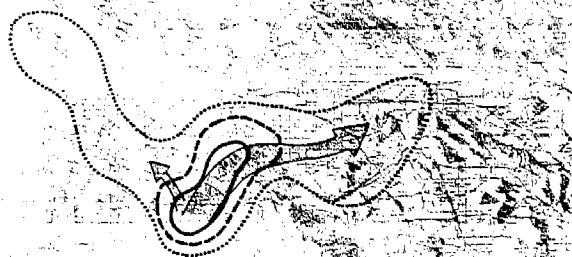
3-4 August 1973

TRACER TEST SUMMARY

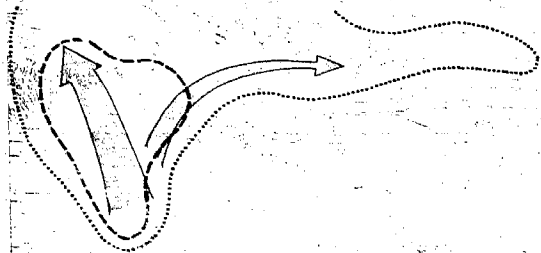
ME-TRONICS 107



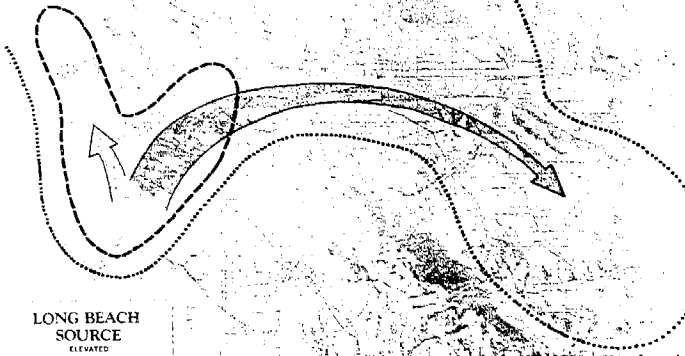
LOS ANGELES
SOURCE



SANTA ANA
SOURCE



TORRANCE
SOURCE



LONG BEACH
SOURCE
ELEVATED

TRACER RELEASED FROM 0600 - 0900 PST

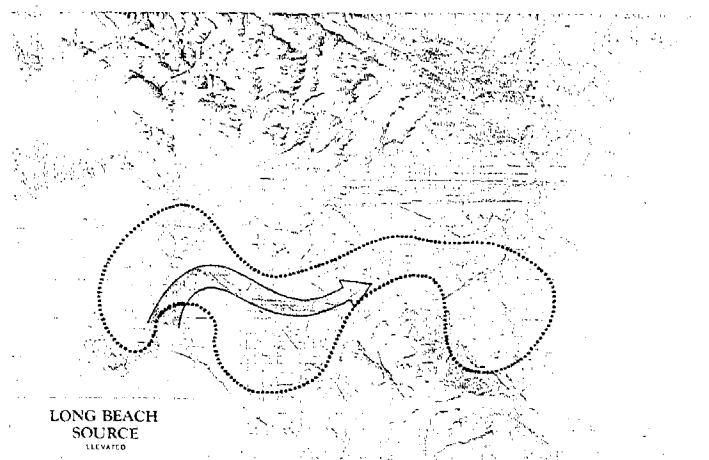
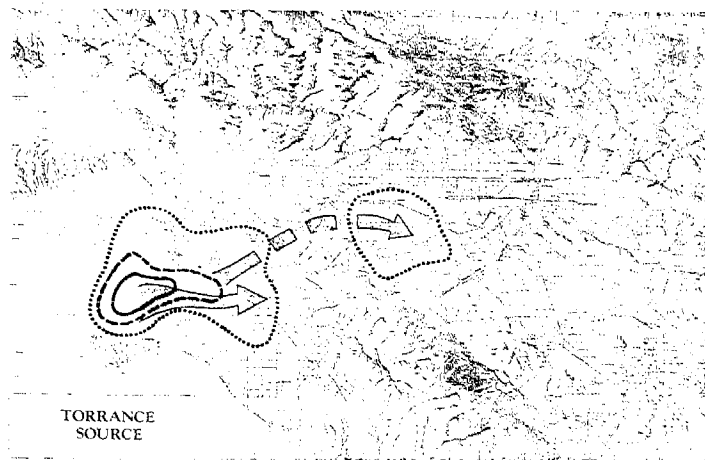
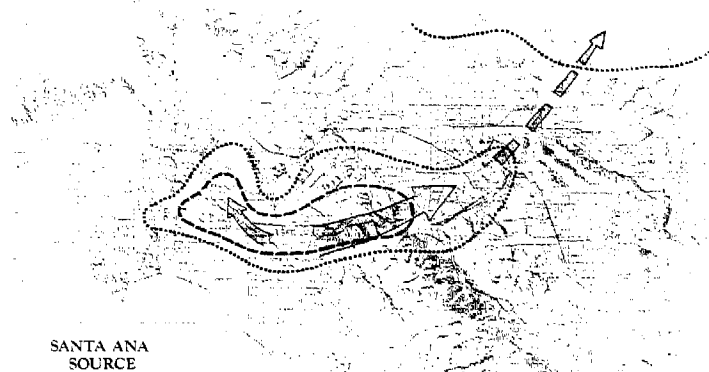
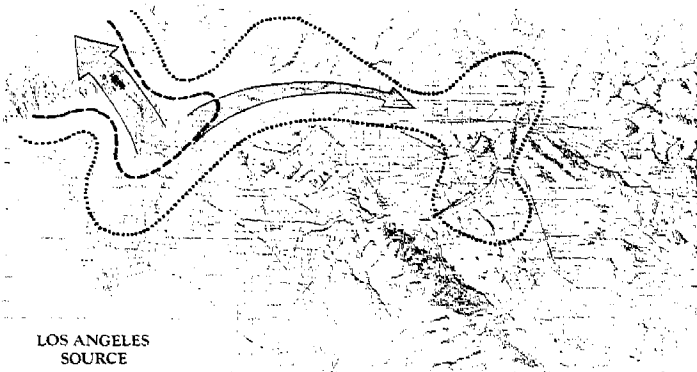
Contours represent an effective average concentration of tracer material from a normalized source of 5×10^{14} particles.
 = 1
 - - - - - = 10
 ————— = 100
 ————— = 1000
 * Number of particles per cubic meter.

Indicates predominant trajectory

0 5 10 20 30
Map Scale in Miles



TRACER TEST SUMMARY



TRACER RELEASED FROM 0600 - 1100 PST

Contours represent an effective average concentration of tracer material from a normalized source of 5×10^{14} particles.

..... 1* - - - - - 10
- - - - - 100 - - - - - 1000

* Number of particles per cubic meter.

→ Indicates predominant trajectory

0 5 10 20 30
Map Scale in Miles



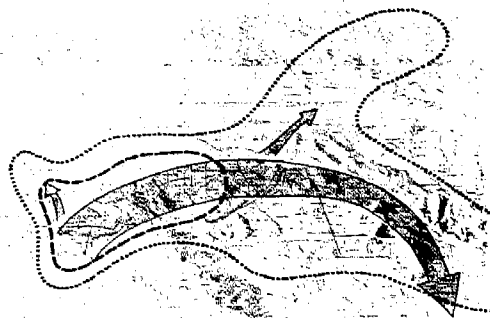
Test C 29-30 September 1973

TRACER TEST SUMMARY

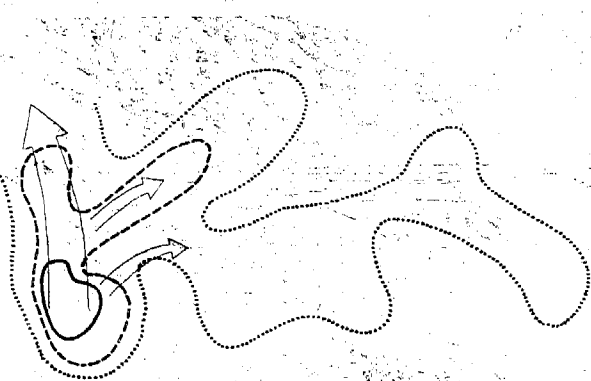
109



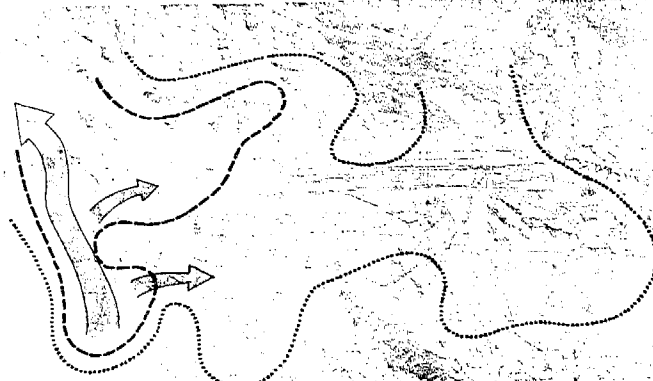
LOS ANGELES
SOURCE



SANTA ANA
SOURCE



TORRANCE
SOURCE



LONG BEACH
SOURCE

TRACER RELEASED FROM 0600 - 1100 PST

Contours represent an effective average concentration of tracer material from a normalized source of 4×10^{14} particles.
 $\times 1$ $\times 10$
 - - - - - $\times 100$ - - - - - $\times 1000$
 * Number of particles per cubic meter.

Indicates predominant trajectory

0 5 10 20 30
Miles Scale in Miles



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APPENDICES

APPENDIX A

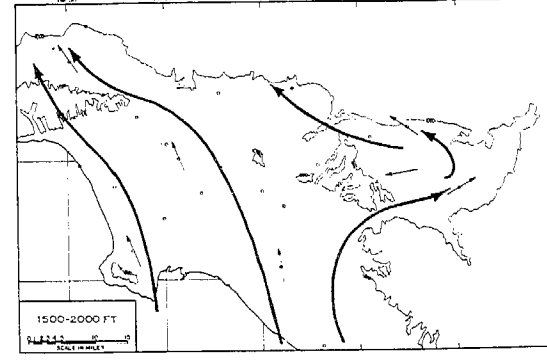
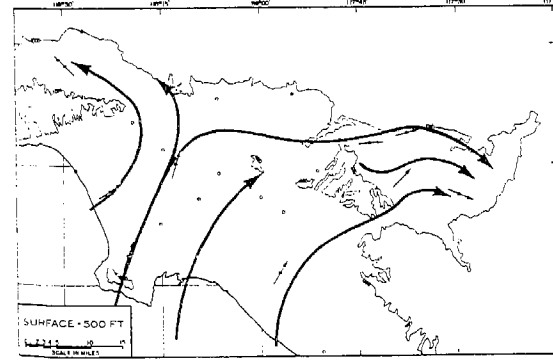
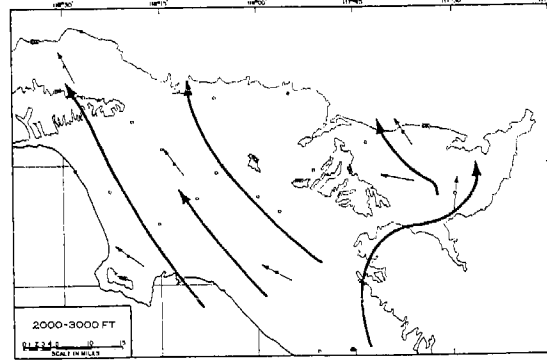
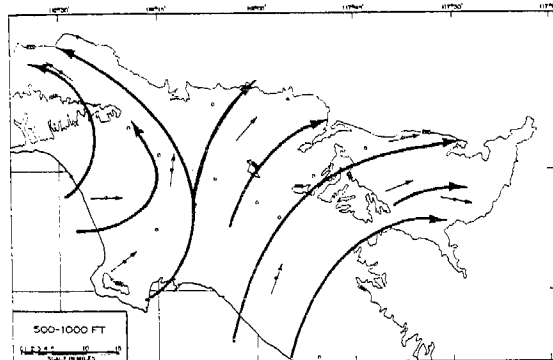
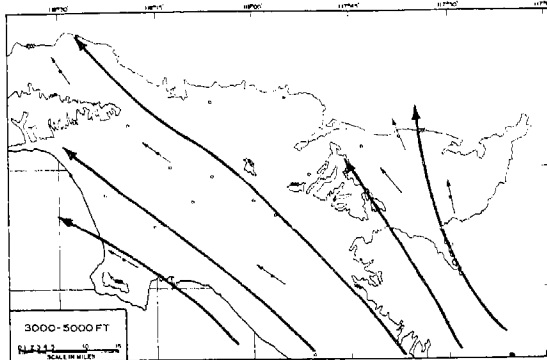
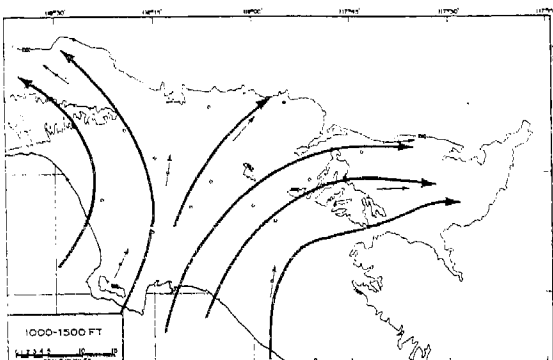
UPPER LEVEL WIND STREAMLINES

Test A 113

Test B 119

Test C 125

Wind Streamlines Aloft
Test A
3 August 1973
0900-1200 PST

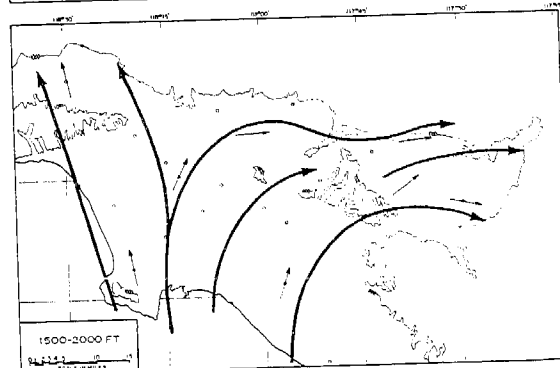
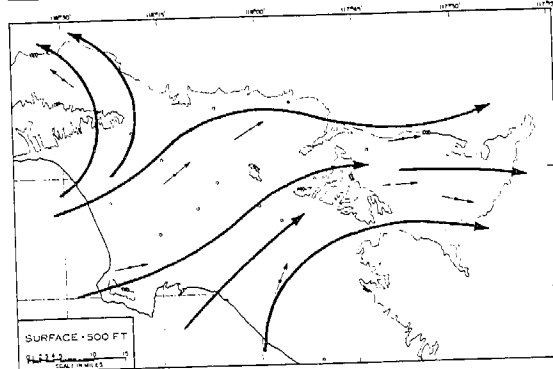
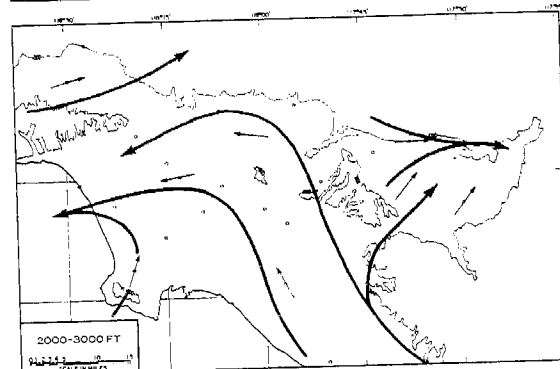
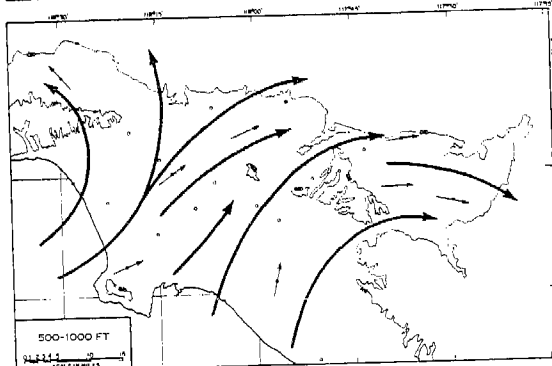
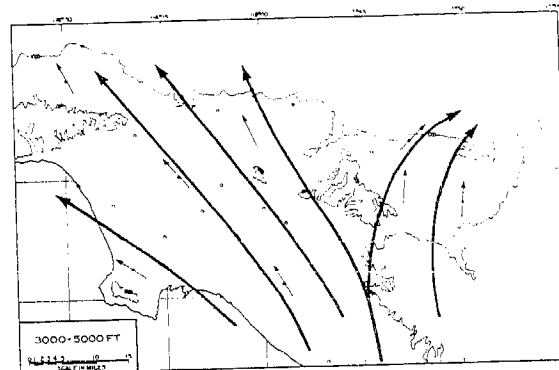
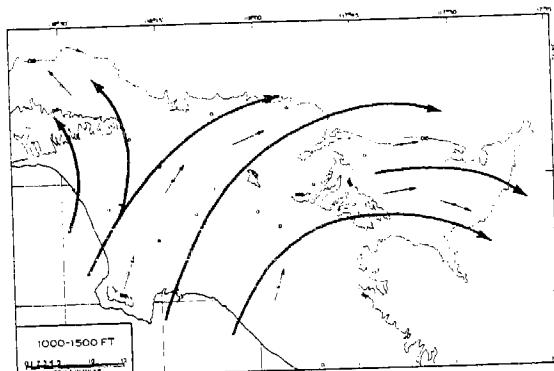


Wind Streamlines Aloft

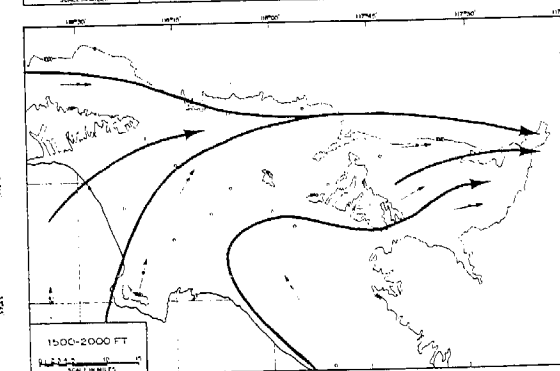
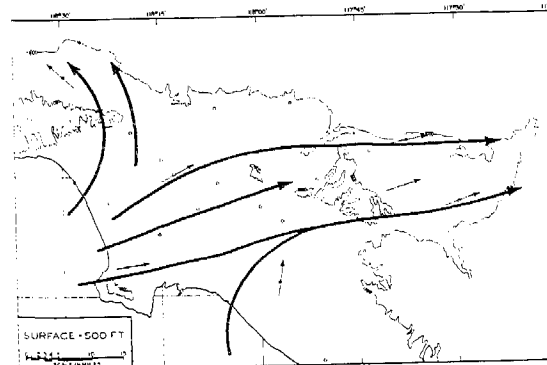
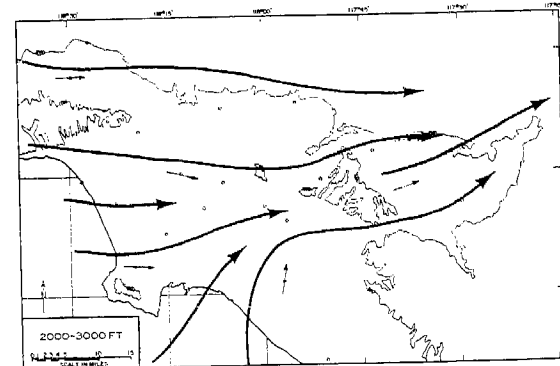
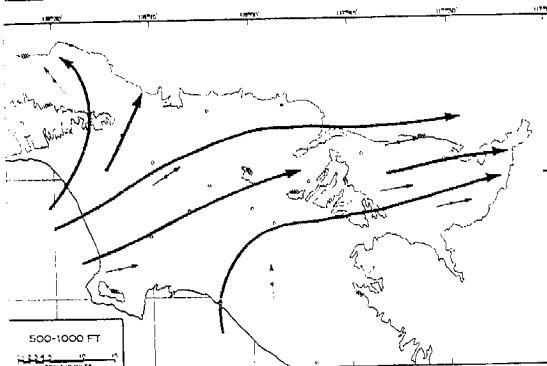
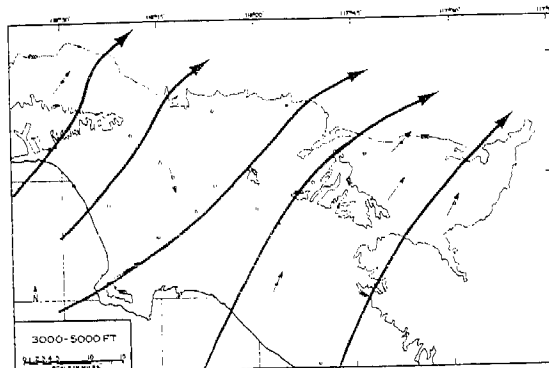
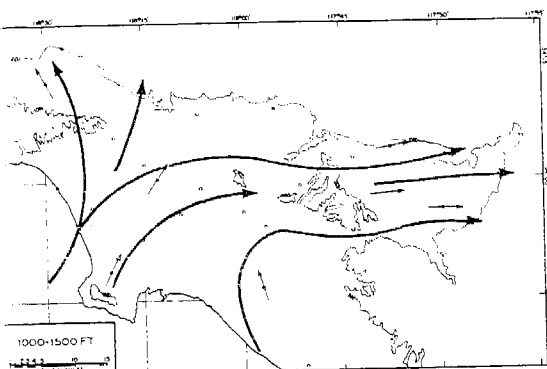
Test A

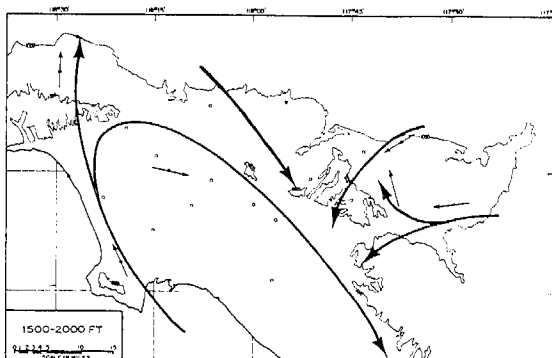
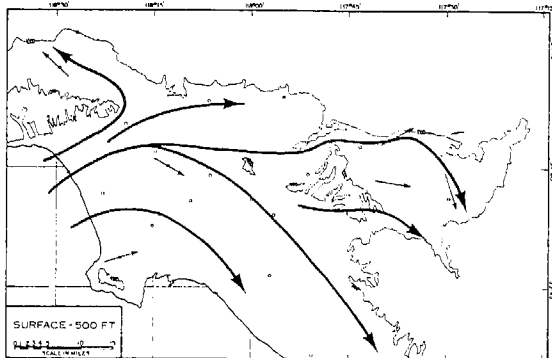
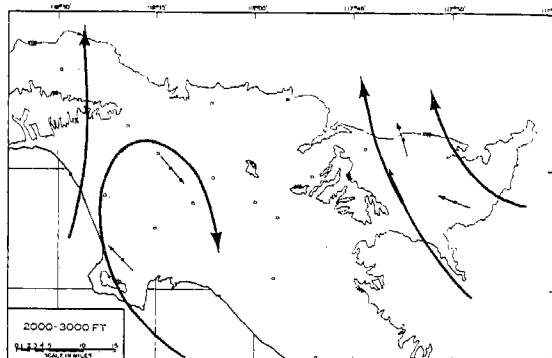
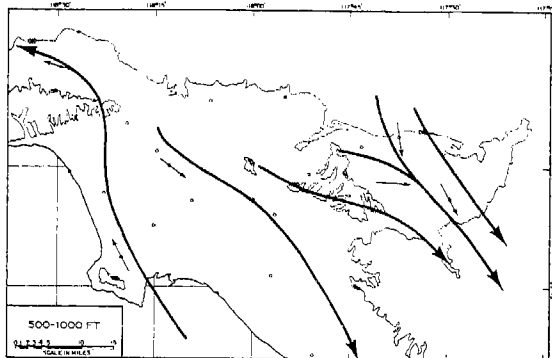
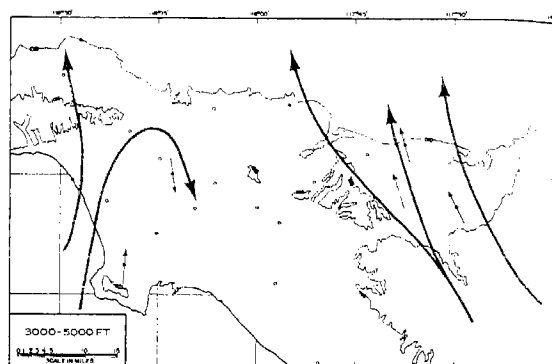
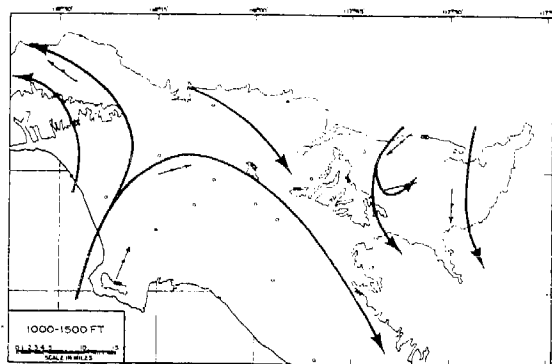
3 August 1973

1200-1500 PST

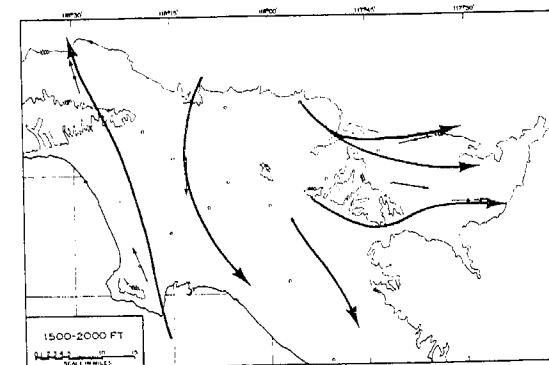
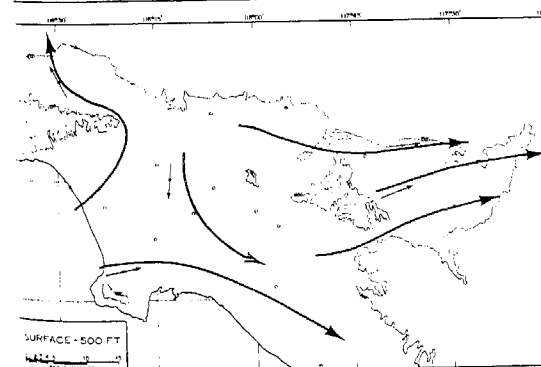
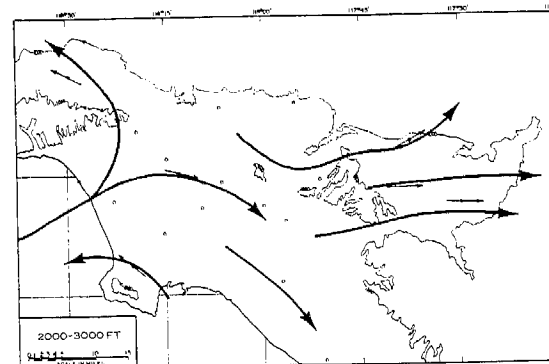
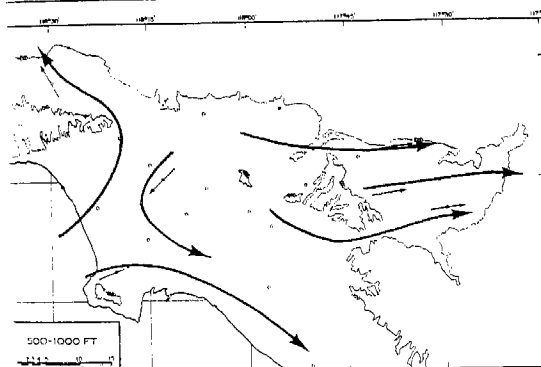
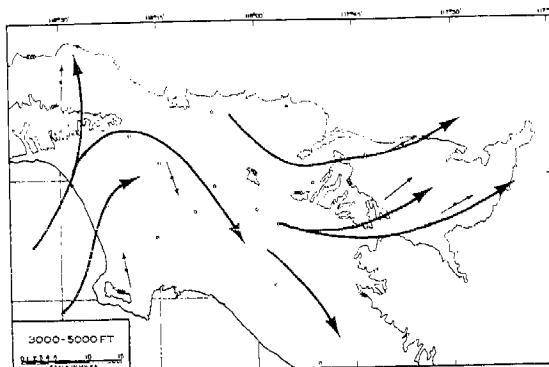
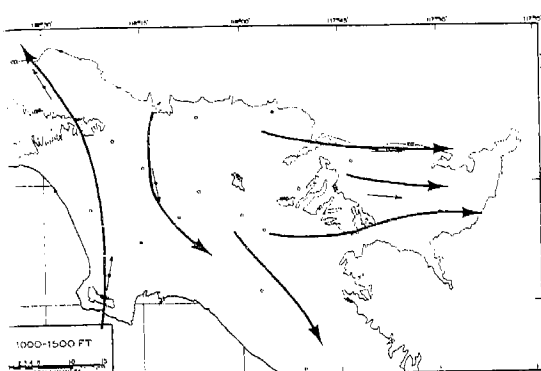


Wind Streamlines Aloft
Test A
3 August 1973
1500-1800 PST

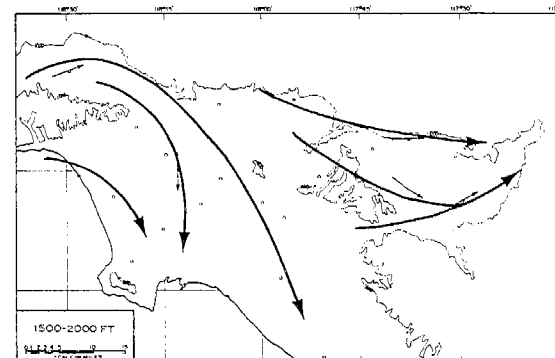
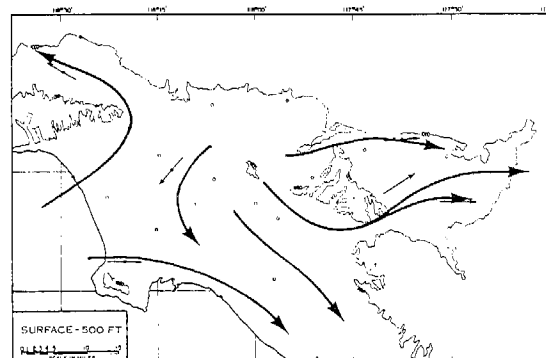
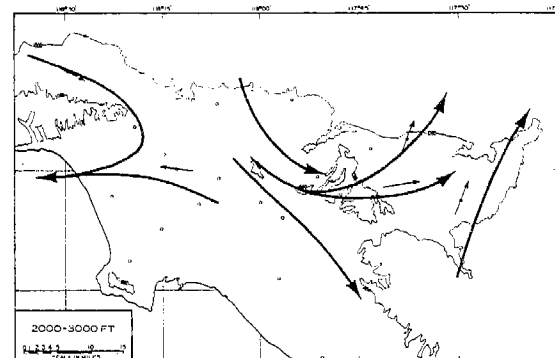
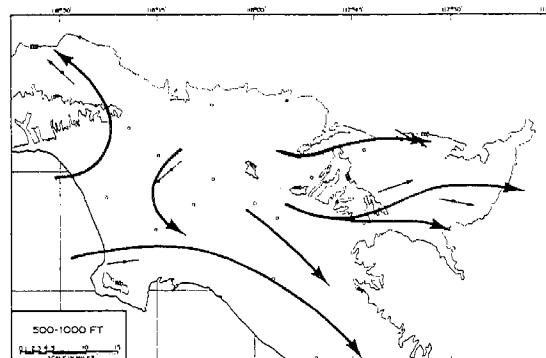
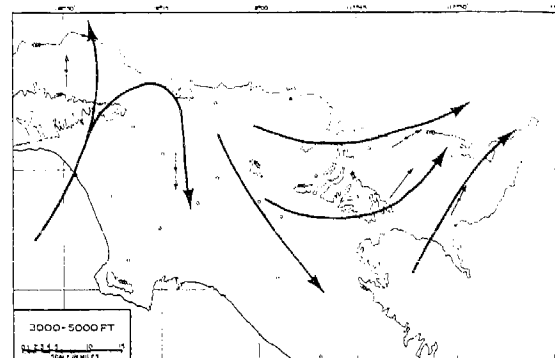
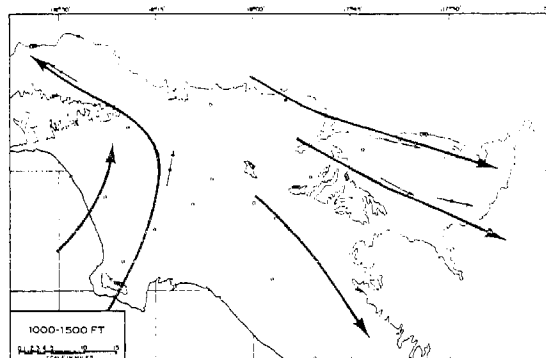


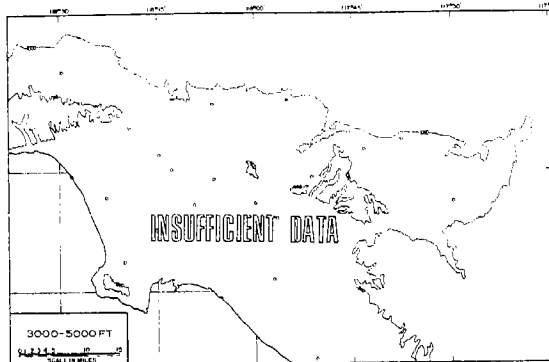
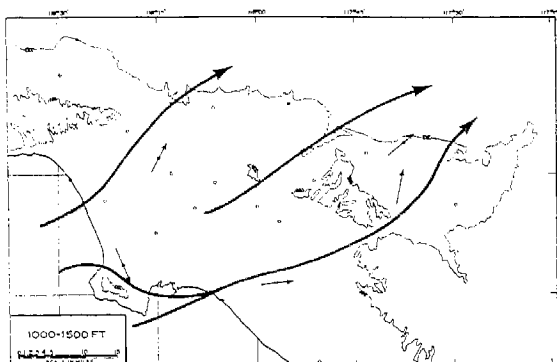
Wind Streamlines Aloft**Test A****4 August 1973****0900-1200 PST**

Wind Streamlines Aloft
Test A
4 August 1973
1200-1500 PST

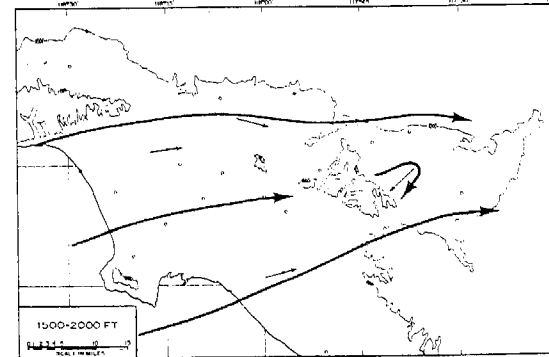
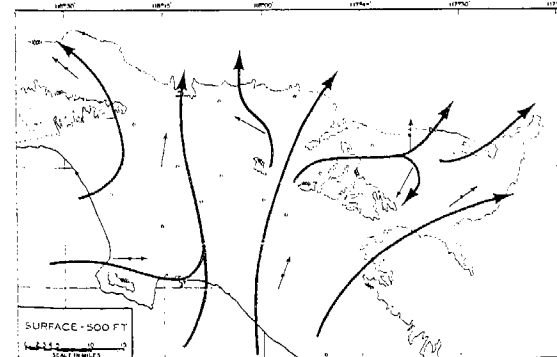
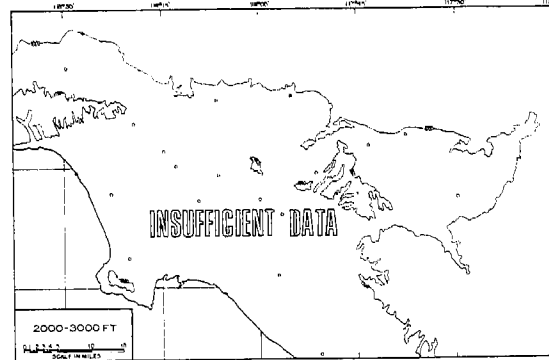
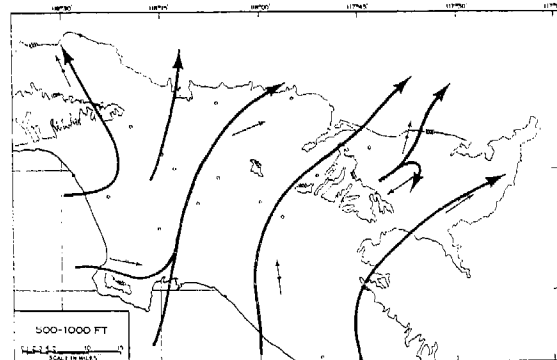


Wind Streamlines Aloft
Test A
4 August 1973
1500-1800 PST

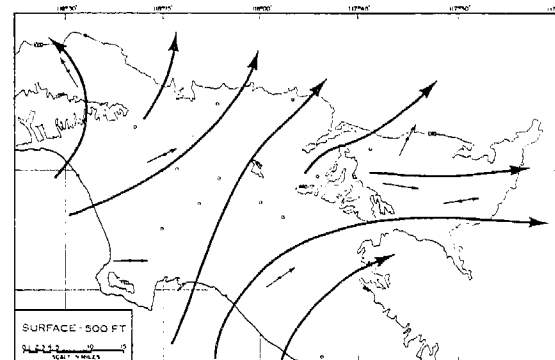
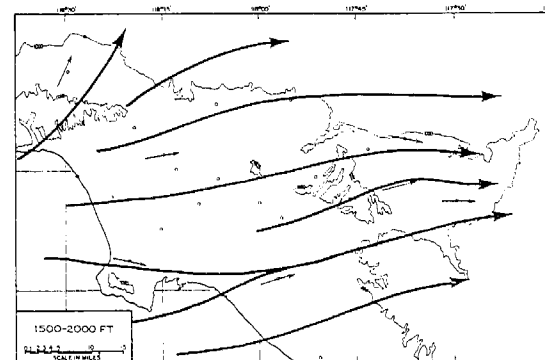
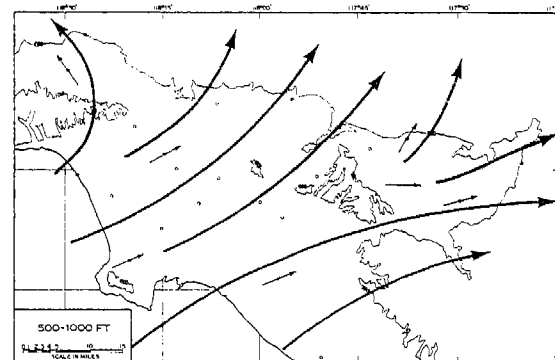
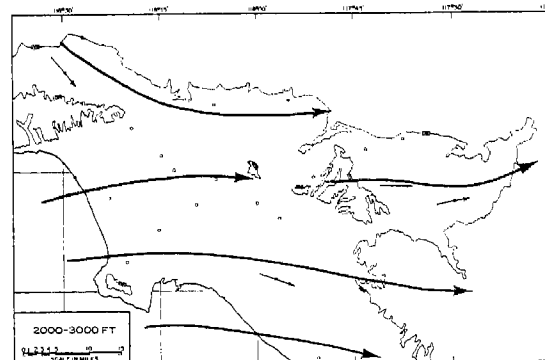
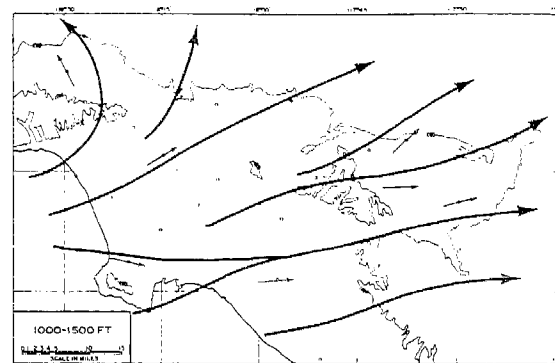
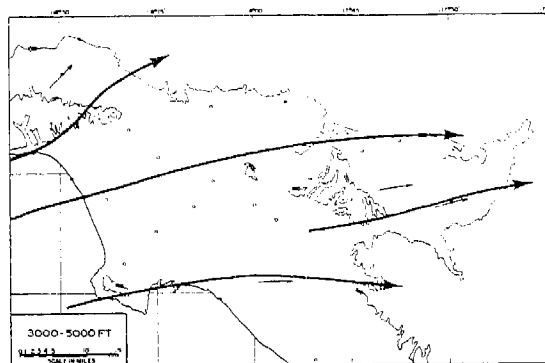




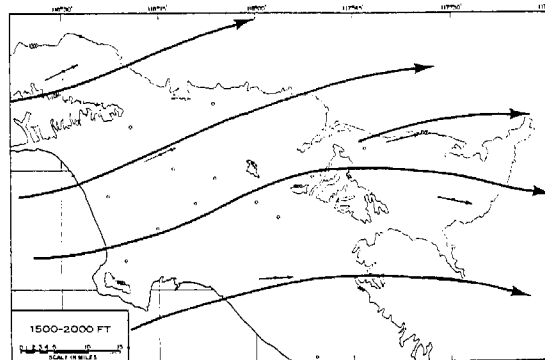
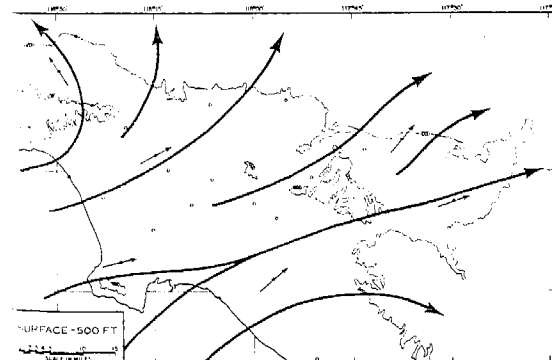
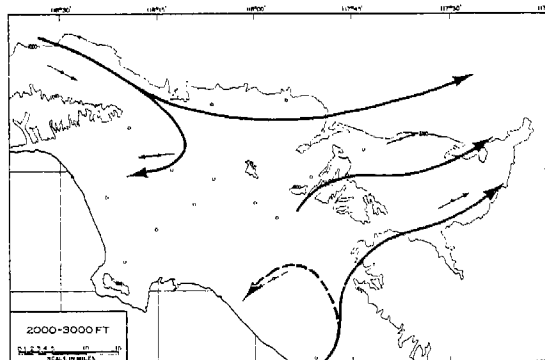
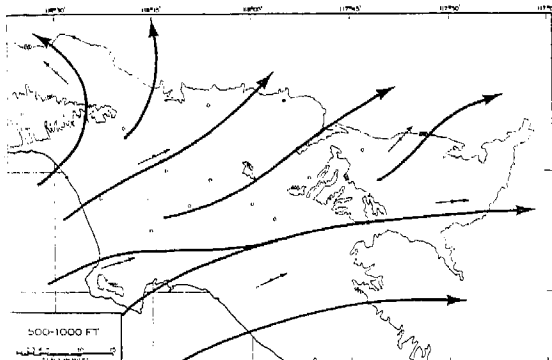
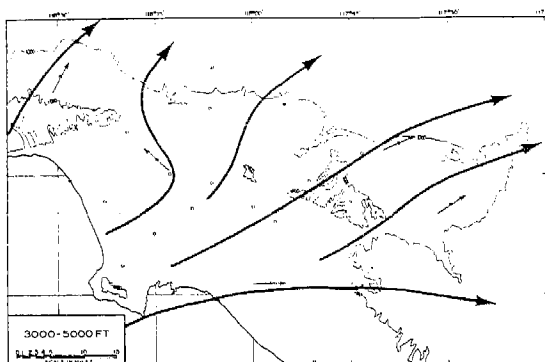
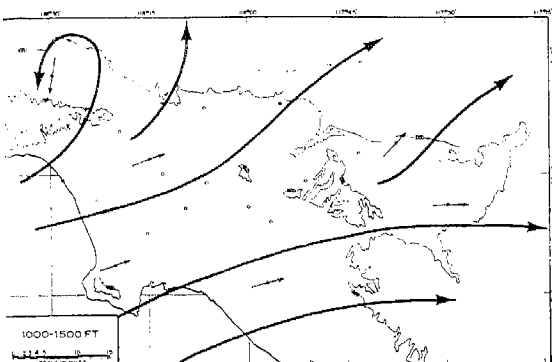
Wind Streamlines Aloft
Test B
13 September 1973
0900-1200 PST



Wind Streamlines Aloft
Test B
13 September 1973
1200-1500 PST



Wind Streamlines Aloft
Test B
13 September 1973
1500-1800 PST

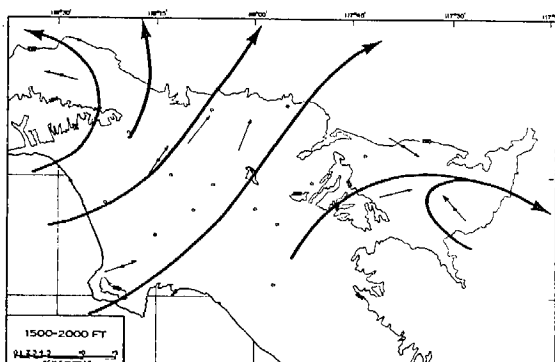
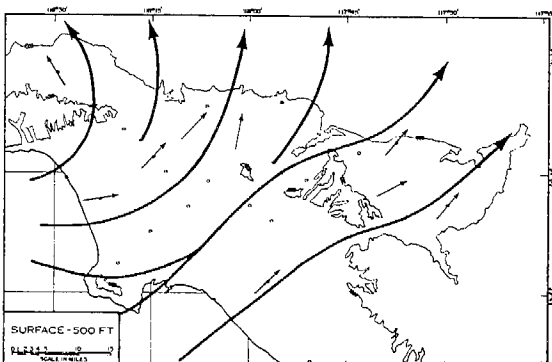
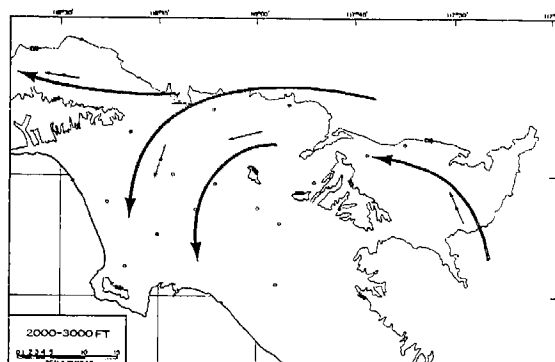
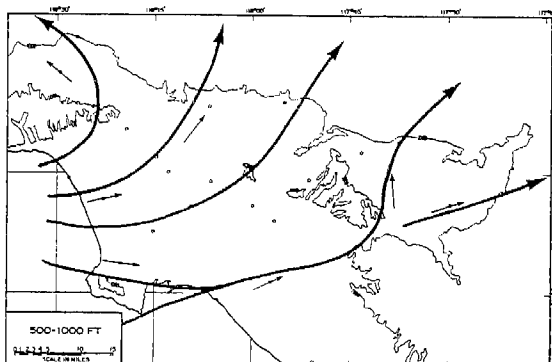
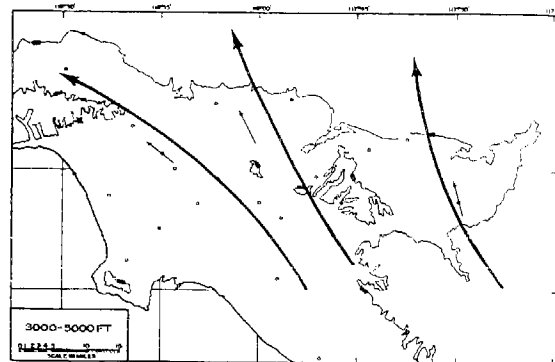
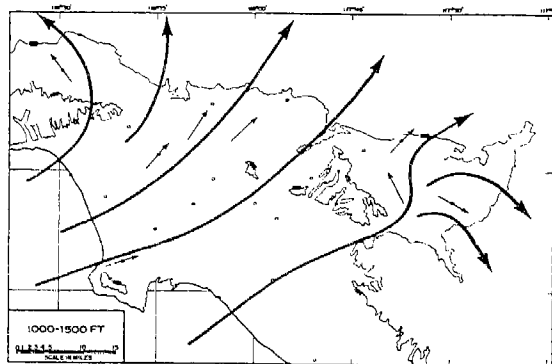


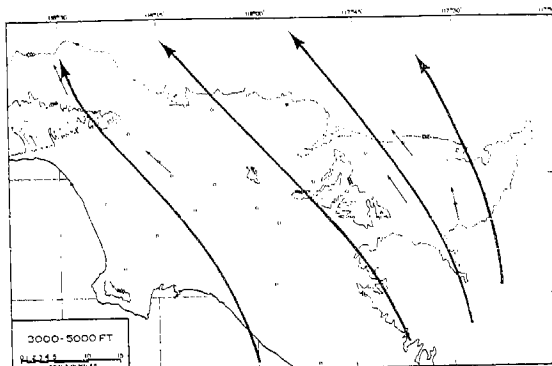
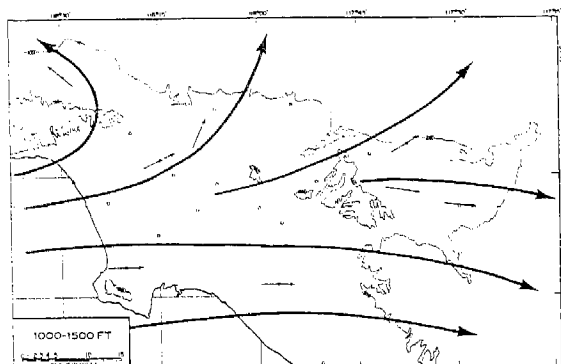
Wind Streamlines Aloft

Test B

14 September 1973

0900-1200 PST



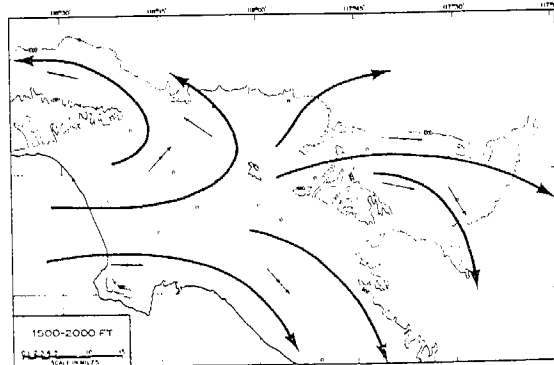
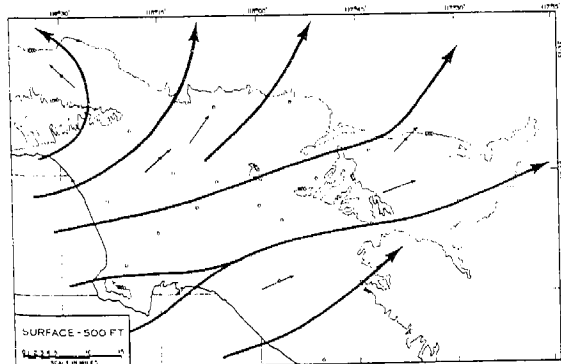
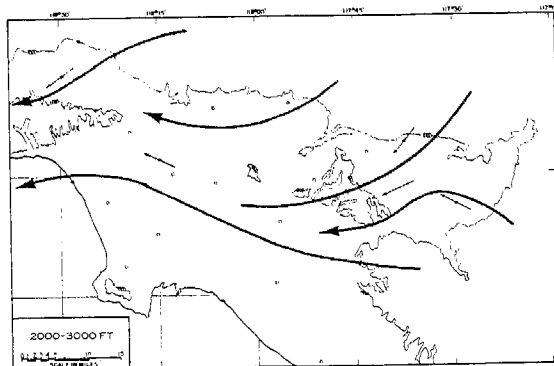
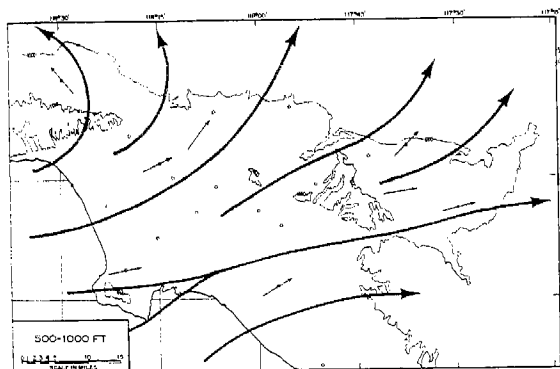


Wind Streamlines Aloft

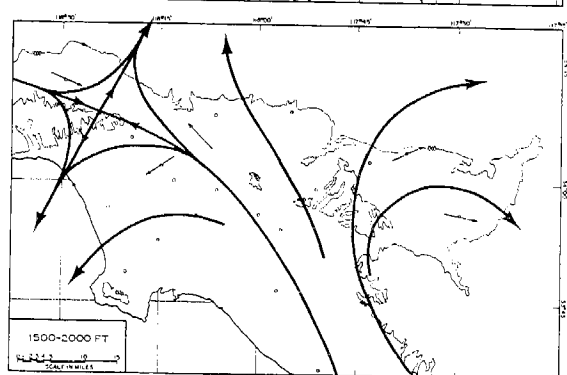
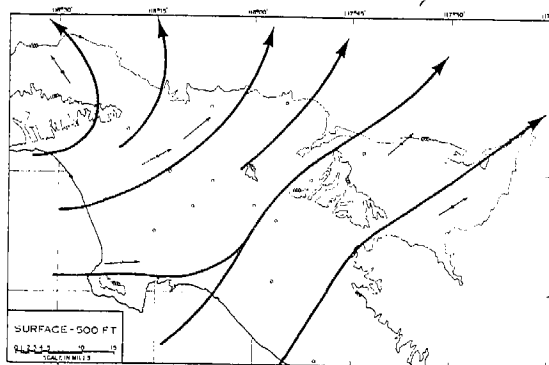
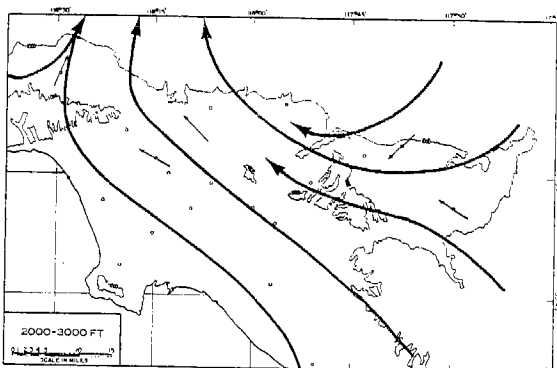
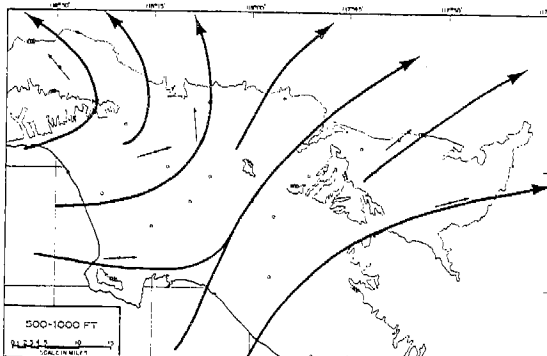
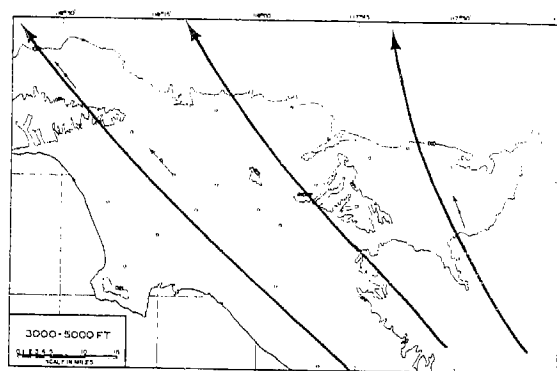
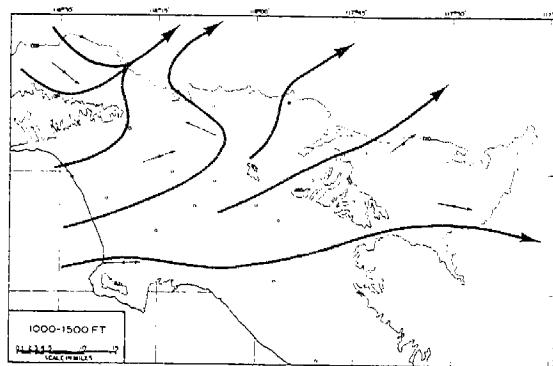
Test B

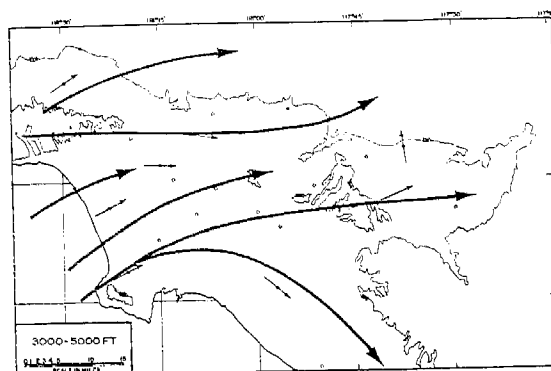
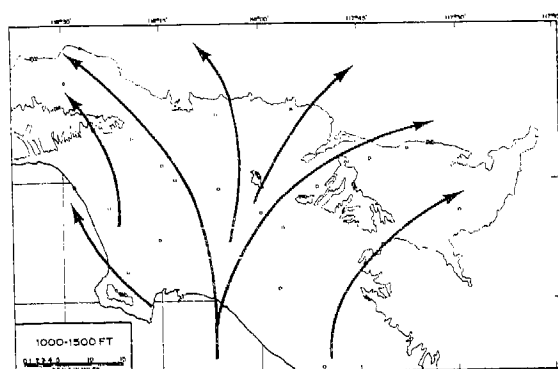
14 September 1973

1200-1500 PST

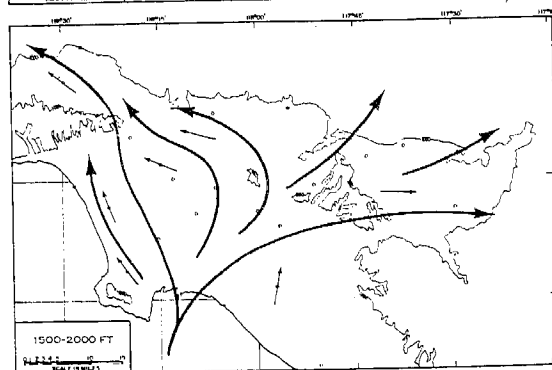
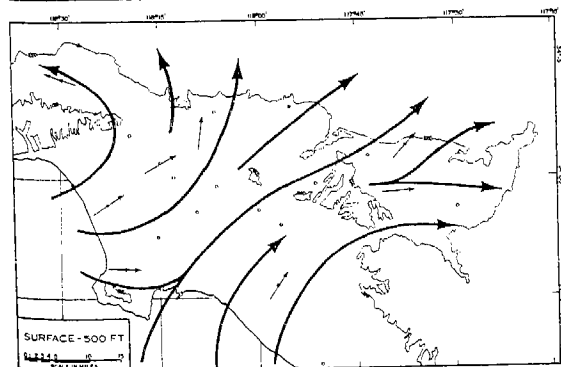
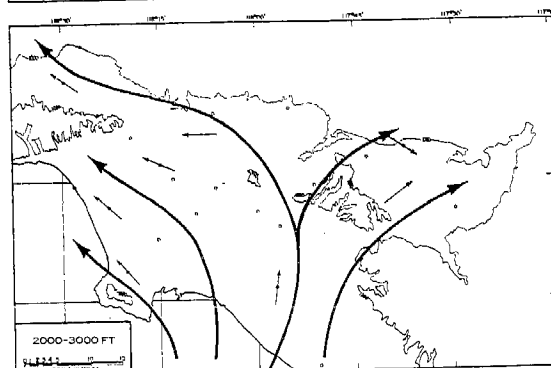
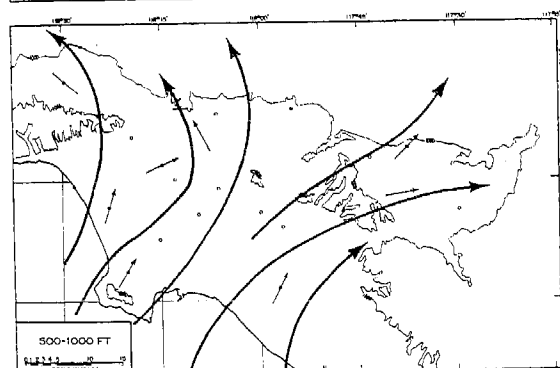


Wind Streamlines Aloft
Test B
14 September 1973
1500-1800 PST





Wind Streamlines Aloft
Test C
29 September 1973
0900-1200 PST

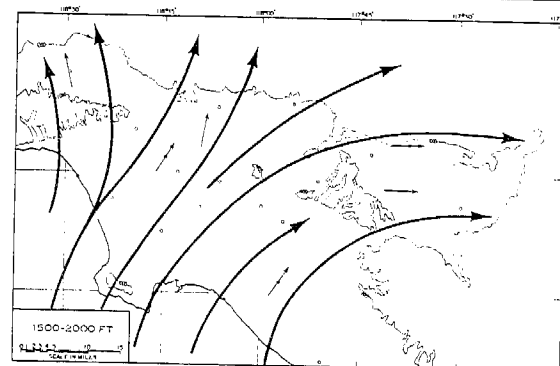
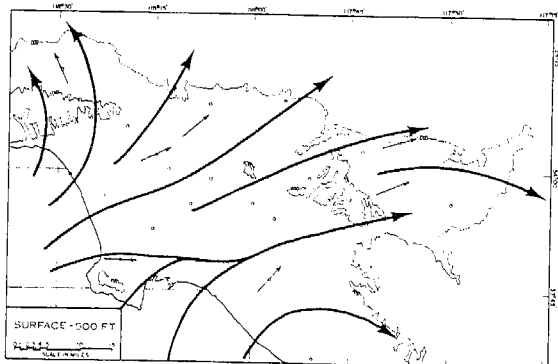
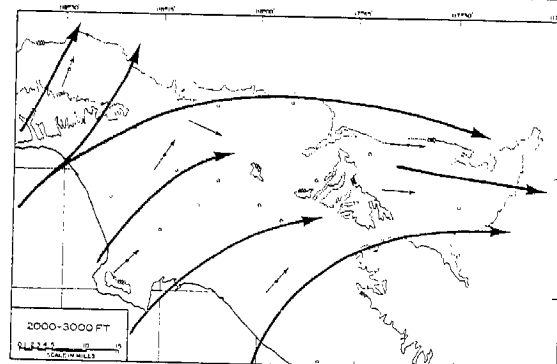
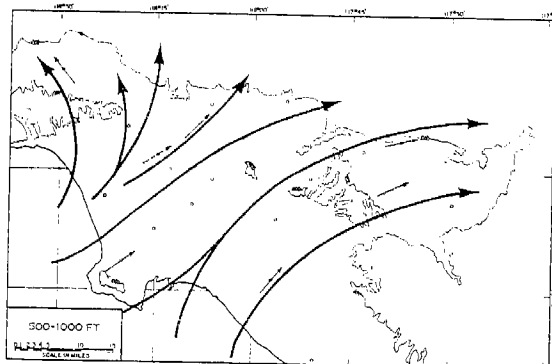
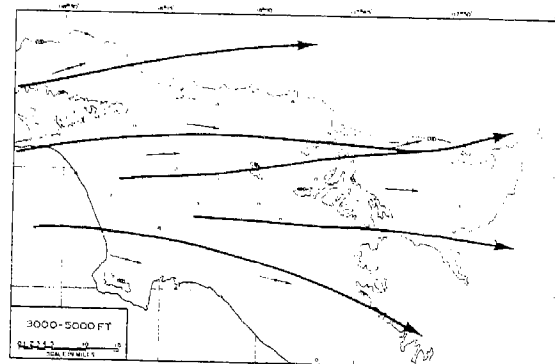
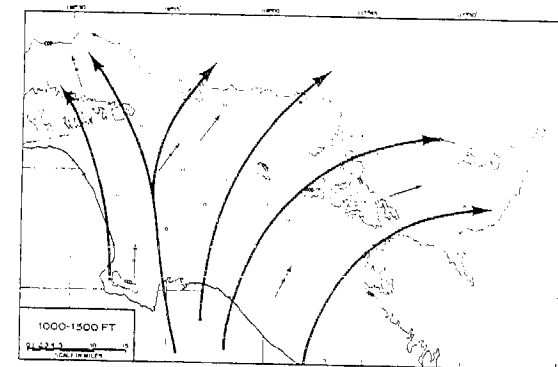


Wind Streamlines Aloft

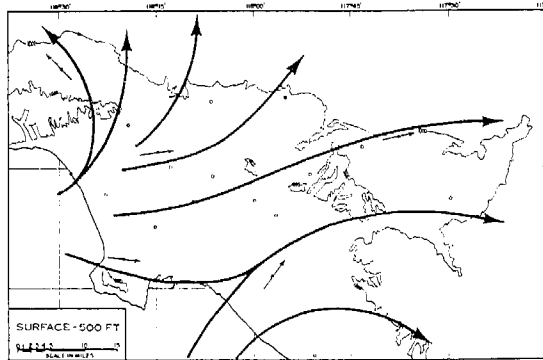
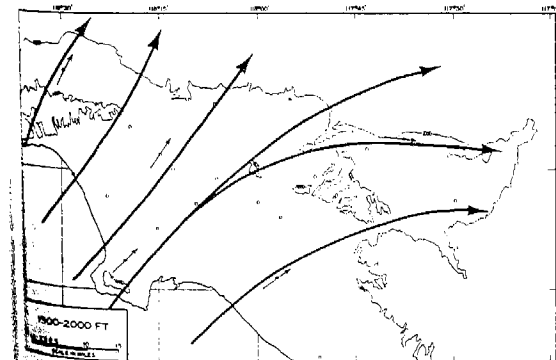
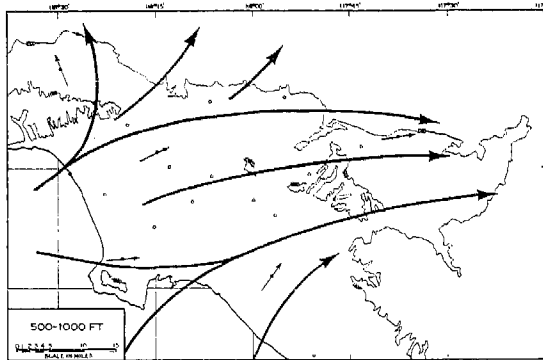
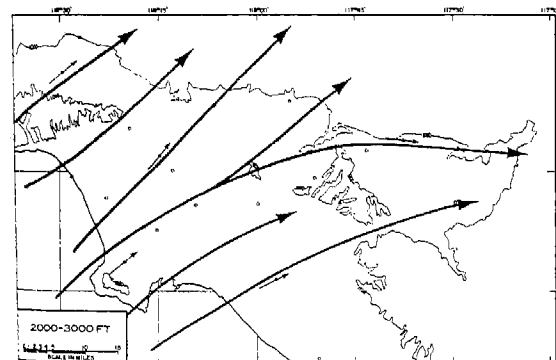
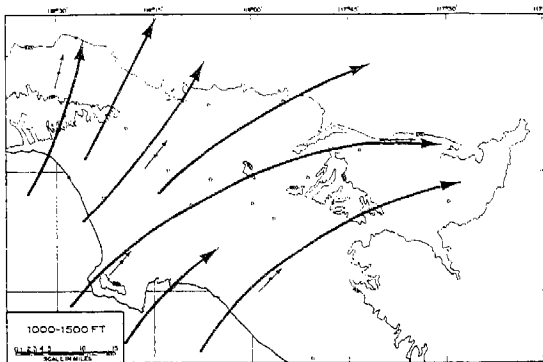
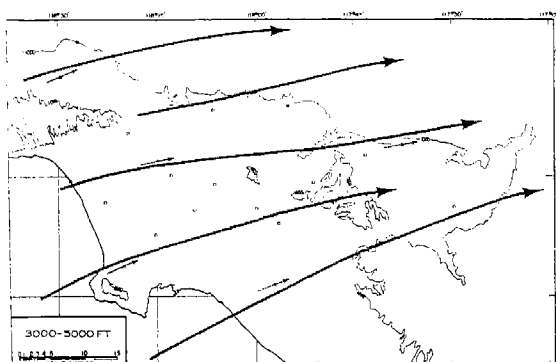
Test C

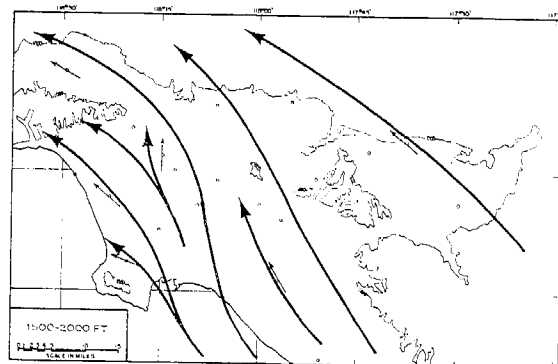
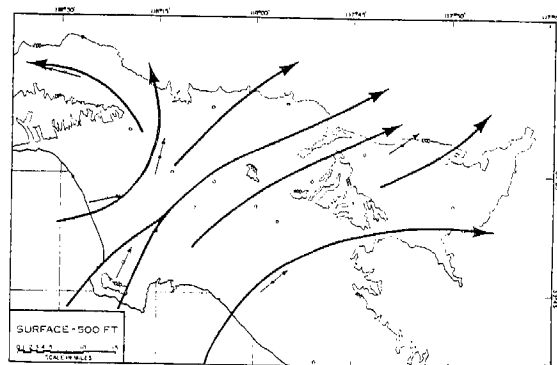
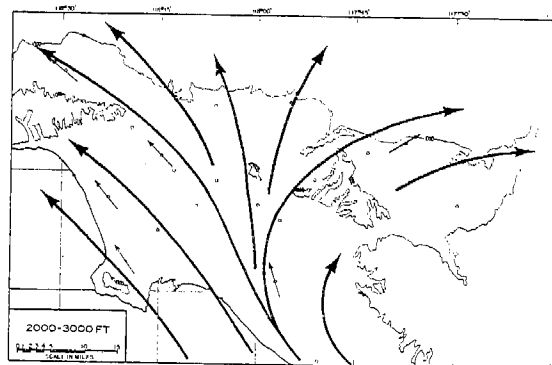
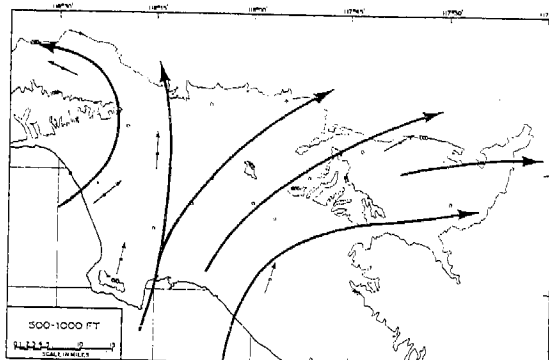
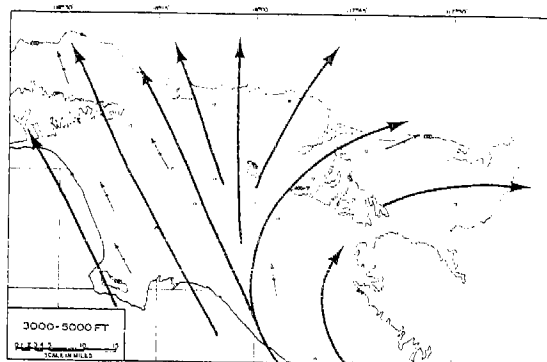
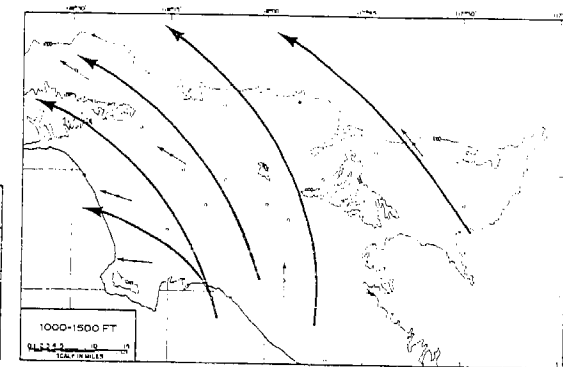
29 September 1973

1200-1500 PST

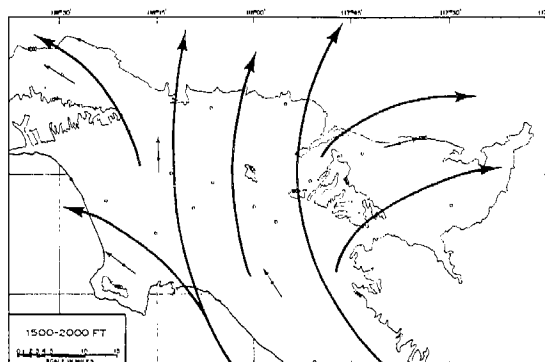
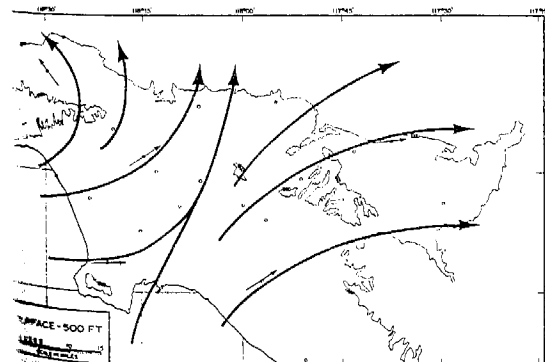
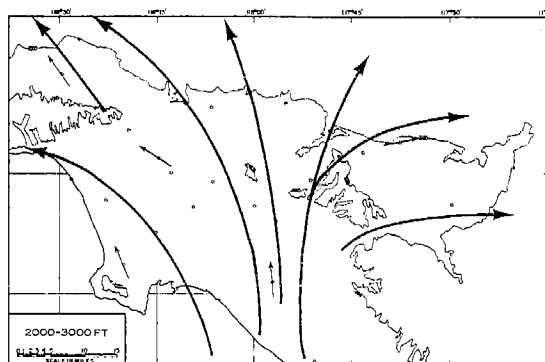
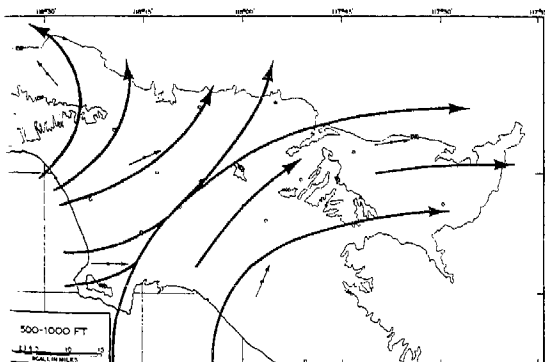
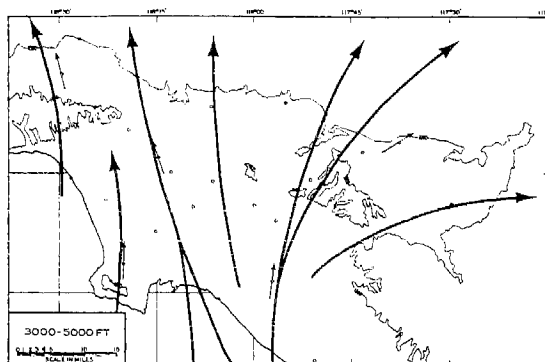
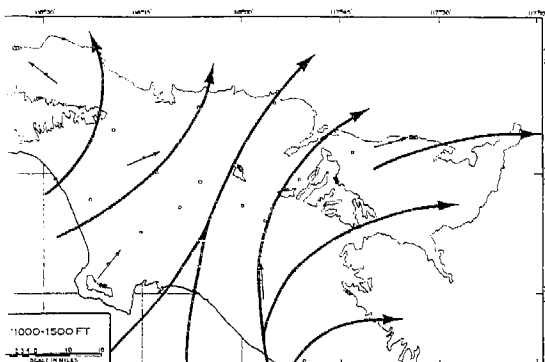


Wind Streamlines Aloft
Test C
29 September 1973
1500-1800 PST



Wind Streamlines Aloft**Test C****30 September 1973****0900-1200 PST**

Wind Streamlines Aloft
Test C
30 September 1973
1200-1500 PST

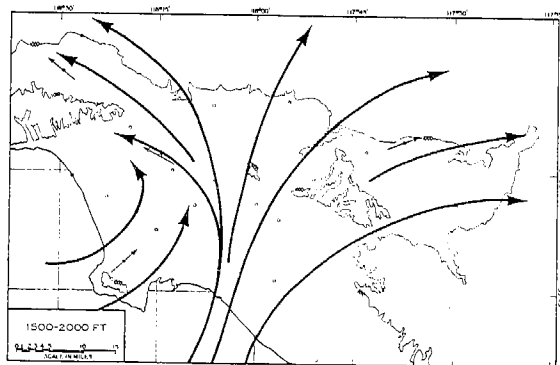
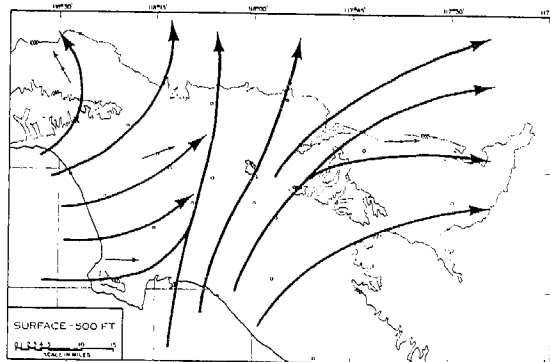
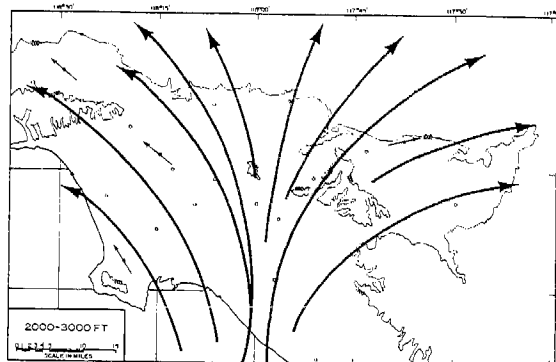
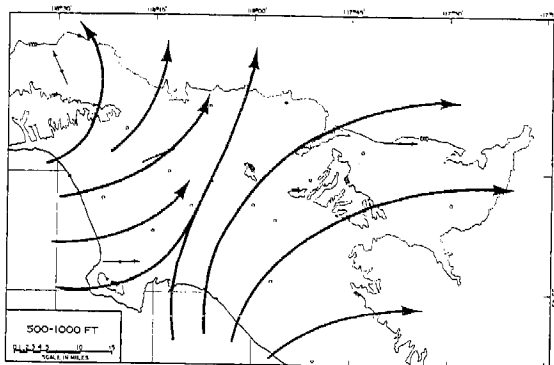
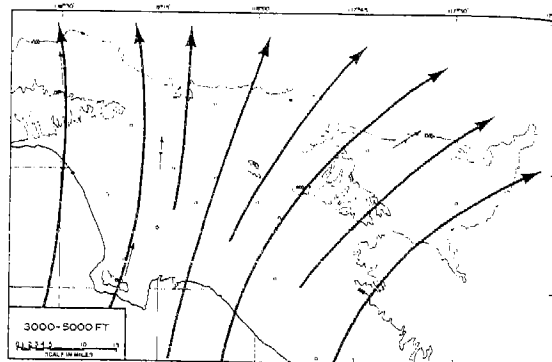
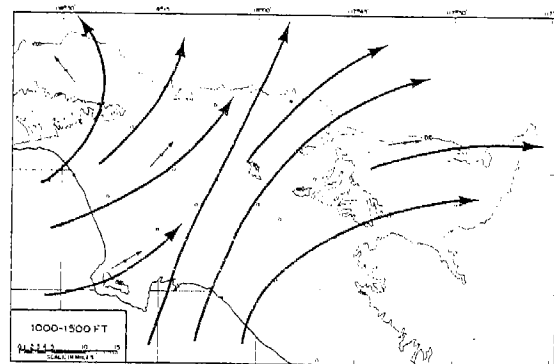


Wind Streamlines Aloft

Test C

30 September 1973

1500-1800 PST



APPENDIX B

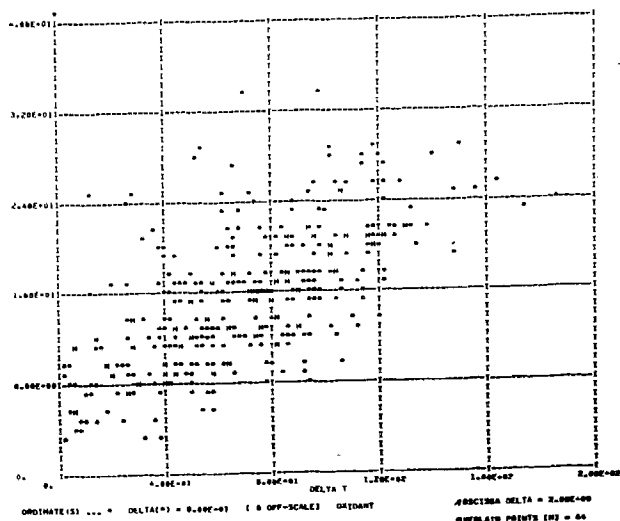
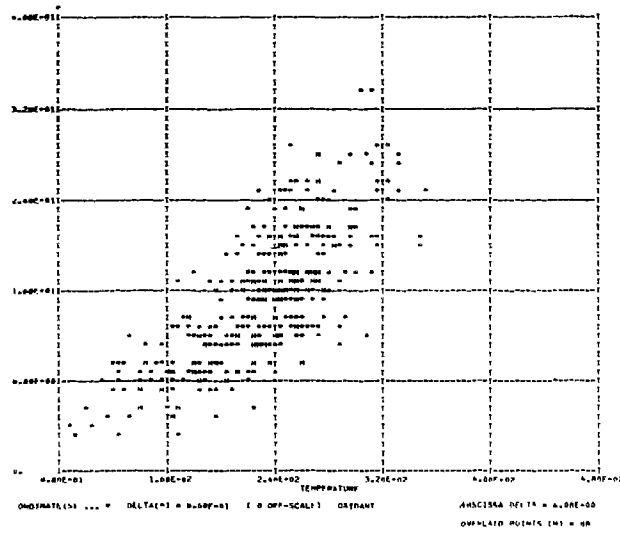
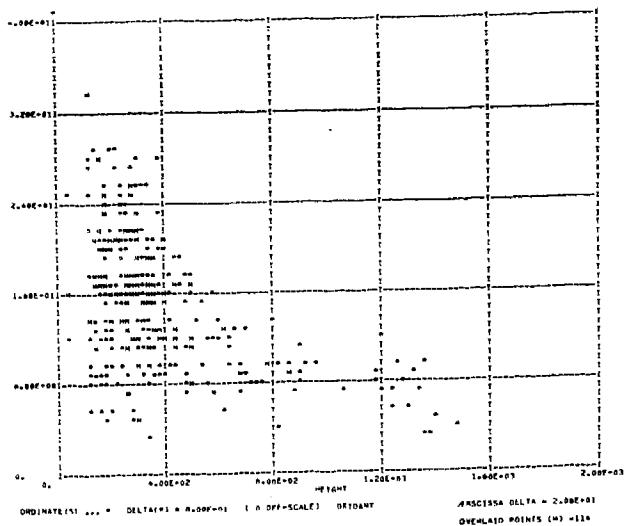
POLLUTION POTENTIAL CORRELATION GRAPHS

Temperature at the top of the inversion vs. Oxidant Height of the base of the inversion vs. Oxidant Temperature difference through the inversion vs. Oxidant. **132**

Height of the base of the inversion vs. Temperature at the top of the inversion (3 ranges of Oxidant concentration). **133**

Temperature difference through the inversion vs. Temperature at the top of the inversion (3 ranges of Oxidant concentration). **134**

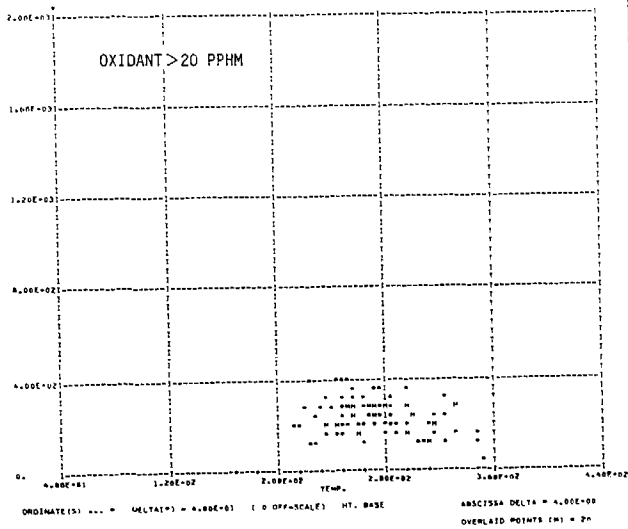
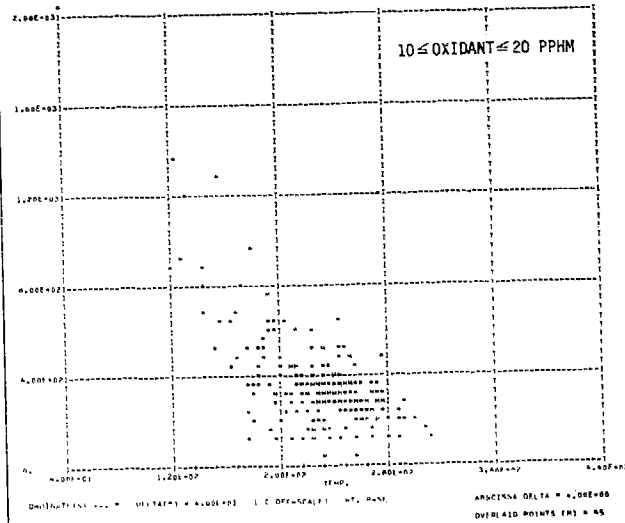
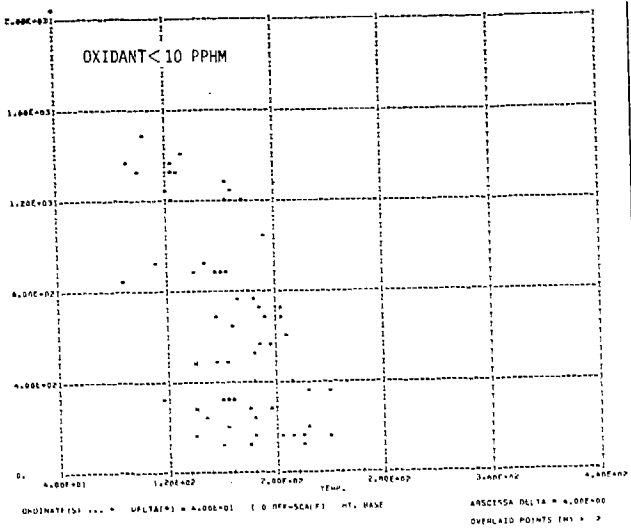
Height of the base of the inversion vs. Temperature difference through the inversion (3 ranges of Oxidant concentration). **135**



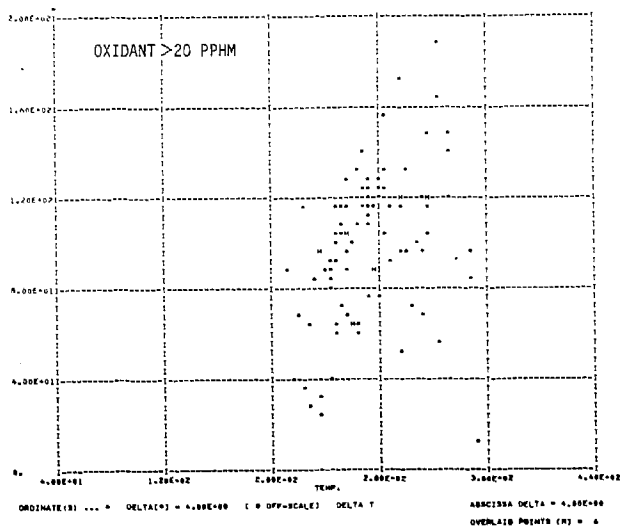
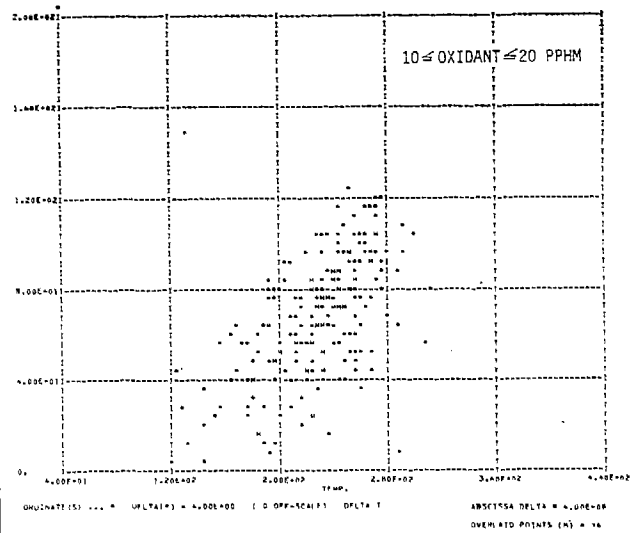
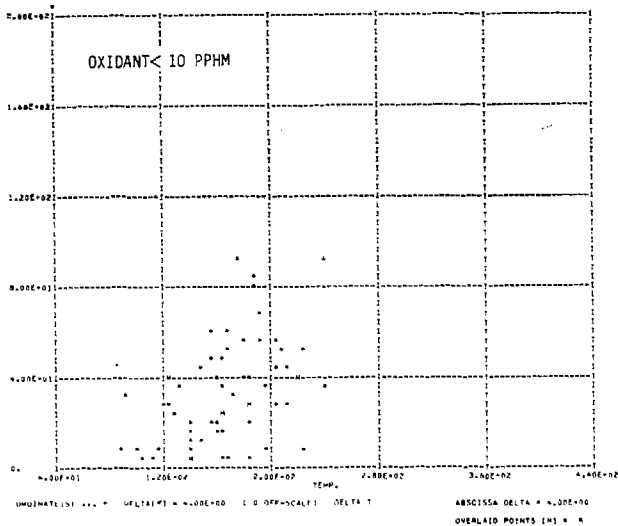
OXIDANT vs TEMPERATURE AT TOP OF INVERSION

OXIDANT vs HEIGHT OF INVERSION BASE

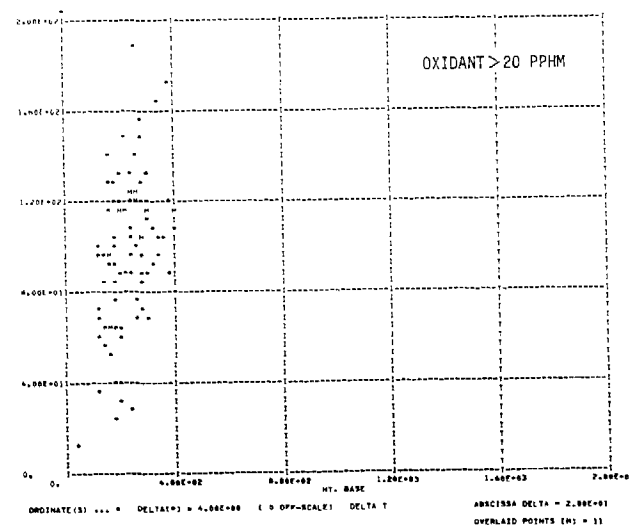
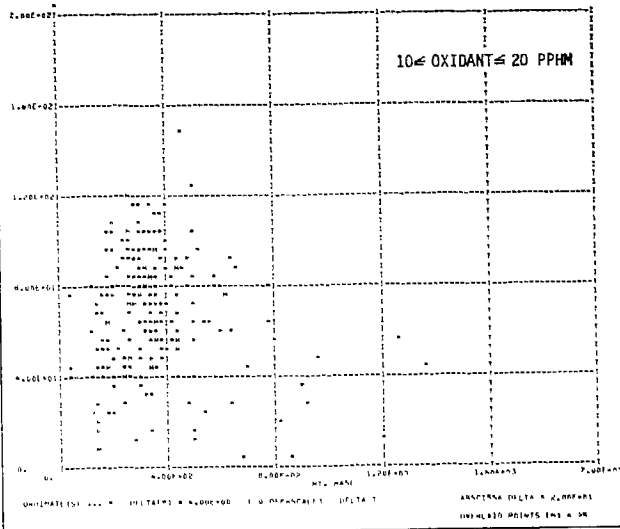
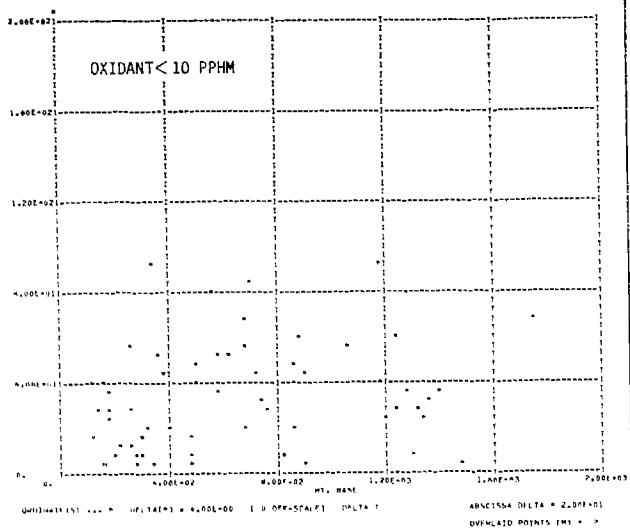
OXIDANT vs DELTA T



HEIGHT OF BASE vs. TEMPERATURE AT TOP OF INVERSION



DELTA T vs TEMPERATURE AT TOP OF INVERSION



DELTA T vs. HEIGHT OF BASE OF INVERSION